

U.S. Corporate R&D

Volume I:

Top 500 Firms in R&D by Industry Category

Topical Report



Office of Technology Policy,
Technology Administration,
U.S. Department of Commerce

Division of Science Resources Studies
Directorate for Social, Behavioral, and Economic Sciences
National Science Foundation



September 1999

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Topical Report

Carl Shepherd, Department of Commerce, Office of Technology Policy, and
Steven Payson, National Science Foundation, Division of Science Resources Studies,
Authors



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FOREWORD

The ability of U.S. industry to compete in global markets depends significantly on a continued, strong investment in scientific knowledge and technology. A confluence of maturing major innovations and accelerating rates of technological progress across many technical fields have contributed considerably to the current surge in U.S. economic growth. Both the creation of technology and the more effective adoption of key technological innovations, such as information and telecommunication systems, are dramatically transforming industrial landscapes. Nevertheless, while all firms may obtain considerable quality and productivity gains through the purchase and deployment of technologies, ultimately, over the long-term, U.S. competitiveness rests on the willingness of firms to risk creating and developing new technologies in the first place.

This report, jointly developed by the U.S. Commerce Department's Office of Technology Policy and the National Science Foundation's Division of Science Resources Studies (SRS), provides perspective on the corporate research and development (R&D) spending that underwrites this essential creative process. While R&D spending has long been used as a proxy for measuring the activities of scientists and engineers, the report introduces the *U.S. Corporate R&D* data series to provide new information and context on the R&D activity of the Nation's top 500 R&D spending corporations. Based on the Standard and Poor's

Compustat database, *U.S. Corporate R&D* is intended to both substantiate existing SRS R&D data series and to provide complementary information for analysts and decision makers. It should be noted, however, that *U.S. Corporate R&D* does not distinguish between different kinds of R&D. According to other 1997 NSF data, more than 93 percent of U.S. industry R&D spending consists of development and applied research. Significantly, while industry spending on development enjoyed robust growth during the 1990s, spending on basic research declined substantially in the mid-1990s, recovering to only 1991 levels in real terms by 1997. Measures of basic research can be found in the SRS special report, *National Patterns of R&D Resources: 1998*.

In addition to a straightforward account of 1996 and 1997 R&D activity of companies and the industries they comprise, the *U.S. Corporate R&D* report sets the baseline and lays groundwork for more in-depth research in the future. For example, subsequent reports that might follow could be expanded to include aggregate industry data for more-extensive categories of industrial R&D performers. These expanded research efforts could provide analysts and planners with information that allows for a clearer understanding of the process of technological change in the United States. It is our hope that, through such improved understanding, both public policies and strategic decisions by private companies could become more effective and successful.

Kelly H. Carnes, Esq.
Acting Assistant Secretary Designate of
Commerce for Technology Policy,
U.S. Department of Commerce

Mary J. Frase
Acting Division Director
Division of Science Resources Studies
National Science Foundation

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This report was written by Carl Shepherd and Steven Payson. Carl Shepherd is a Technology Policy Analyst for the Office of Technology Policy (OTP), Technology Administration (TA), U.S. Department of Commerce (DOC). Steven Payson is a Senior Science Resources Analyst for the Research and Development Statistics (RDS) Program, Division of Science Resources Studies (SRS), National Science Foundation (NSF).

Other individuals from various Federal agencies provided information for inclusion in this report and reviewed the material for accuracy. Significant guidance and review were provided by Jon Paugh, Director for Technology Competitiveness, OTP, and John Jankowski, Program Director, RDS. The project had been originally conceived and initiated by John Jankowski.

Appreciation is expressed to officials of the Economics and Statistics Administration (ESA), DOC for their helpful advice and suggestions. These include Lee Price, Chief Economist, ESA; Barbara Fraumeni, Chief Economist, Bureau of Economic Analysis; Frederick Knickerbocker, Associate Director for Economic Programs, U.S. Bureau of the Census; and Laurence Campbell, Senior Regulatory Policy Analyst, ESA.

SRS staff members providing review of the report included Mary Frase, Acting Division Director; Ron Fecso, Chief Mathematical Statistician; Larry Rausch, Chair of the SRS Peer Review Group; and Melissa Pollak and Raymond Wolfe, who are Senior Analysts. The text was edited by Anne Houghton, Publications Manager with assistance from Julia Harriston and Tanya Gore.

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Finally, gratitude is shown to Jane Adams, Deputy Chief Accountant of the Securities and Exchange Commission for her review and suggestions regarding the section on "R&D Valuation Adjustments."

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EXECUTIVE SUMMARY

A newly developed data series, *U.S. Corporate R&D*, suggests that U.S. industry significantly increased its spending on research and development (R&D) in 1997. In that year, the top 500 R&D-spending corporations in the United States spent a total of \$111 billion of their own funds on R&D, a 9.0-percent increase over the \$102 billion spent by the top 500 R&D spenders in 1996. The \$111 billion spent on R&D by the top 500 R&D corporations is equivalent to 86.8 percent of the total industry-financed and industry-performed R&D in the United States, as reported by the National Science Foundation (NSF) based on data collected by the Bureau of Census. These expenditures also equal 54.2 percent of total U.S. R&D by all performers from all sources.¹

The *U.S. Corporate R&D* data series was built using data from Standard & Poor's *Compustat*² listing for publicly held firms. It was jointly developed by the U.S. Commerce Department's Office of Technology Policy (OTP) and the NSF's Division of Science Resources Studies (SRS). It supplements SRS' data series on U.S. industry R&D spending with timely information on eight major, and 45 detailed, industrial sectors. The new data series features for the years 1996 and 1997 the combined domestic and overseas R&D spending, net sales, capital investment, and employment data by the top 500 publicly-held R&D-spending corporations that are headquartered in the United States.

As a supplement to existing data on U.S. R&D expenditures, the *U.S. Corporate R&D* database meets a variety of analytic needs. First, tallies of latest year R&D spending data are available for firms very soon after the close of their fiscal year. By July of each year, *Compustat* compiles the latest R&D figures for a majority of the 9,800 active U.S. companies in its database. This information can be used to help substantiate SRS R&D spending estimates issued earlier in the year for the most recently completed year. Second, because *Compustat*

provides data on other performance indicators for hundreds of individual firms (e.g., sales, employment, exports, foreign sales, and profits), such additional information could provide immediate context for analyses of industry R&D activity.

Among the eight major industrial sectors used in this report, the information and electronics sector had the highest share of the \$111 billion spent by the top 500 R&D firms in 1997—\$45.8 billion (41 percent). Second was medical substances and devices with \$20 billion (18 percent); followed by motor vehicles and other transportation equipment with \$18 billion (17 percent); basic industries and materials with \$8 billion (8 percent); machinery and electrical equipment with \$7 billion (6 percent); chemicals with \$7 billion as well (6 percent); aircraft, guided missiles, and space vehicles with \$5 billion (4 percent) and other industries (general services, engineering, accounting, research/testing services; and finances, insurance and real estate), with \$0.4 billion (0.4 percent).

Volume 1 of this report, prepared jointly by OTP and SRS, is divided into two sections. The first, "R&D Expenditures by Industry Category," details aggregate data of the *U.S. Corporate R&D* data series for 1996 and 1997. The second section discusses the "purpose and characteristics of the data series" and compares it to the long-established SRS data series on U.S. industry R&D.

Volume 2 of this report, by NSF, is entitled, "Company Information on Top 500 Firms in R&D." It details the R&D expenditures and other financial characteristics of each of the top 500 firms in R&D in 1996 and 1997. This information is available because the Securities and Exchange Commission (SEC) requires public corporations to provide such information in detailed financial reports.

¹ These proportions are based on national R&D data provided in Table B-1A of National Science Foundation, *National Patterns of R&D Resources: 1998*, by Steven Payson, NSF 99-335 (Arlington, VA 1999).

² Standard & Poor's *Compustat*, Englewood, Colorado.

R&D EXPENDITURES BY INDUSTRY CATEGORY

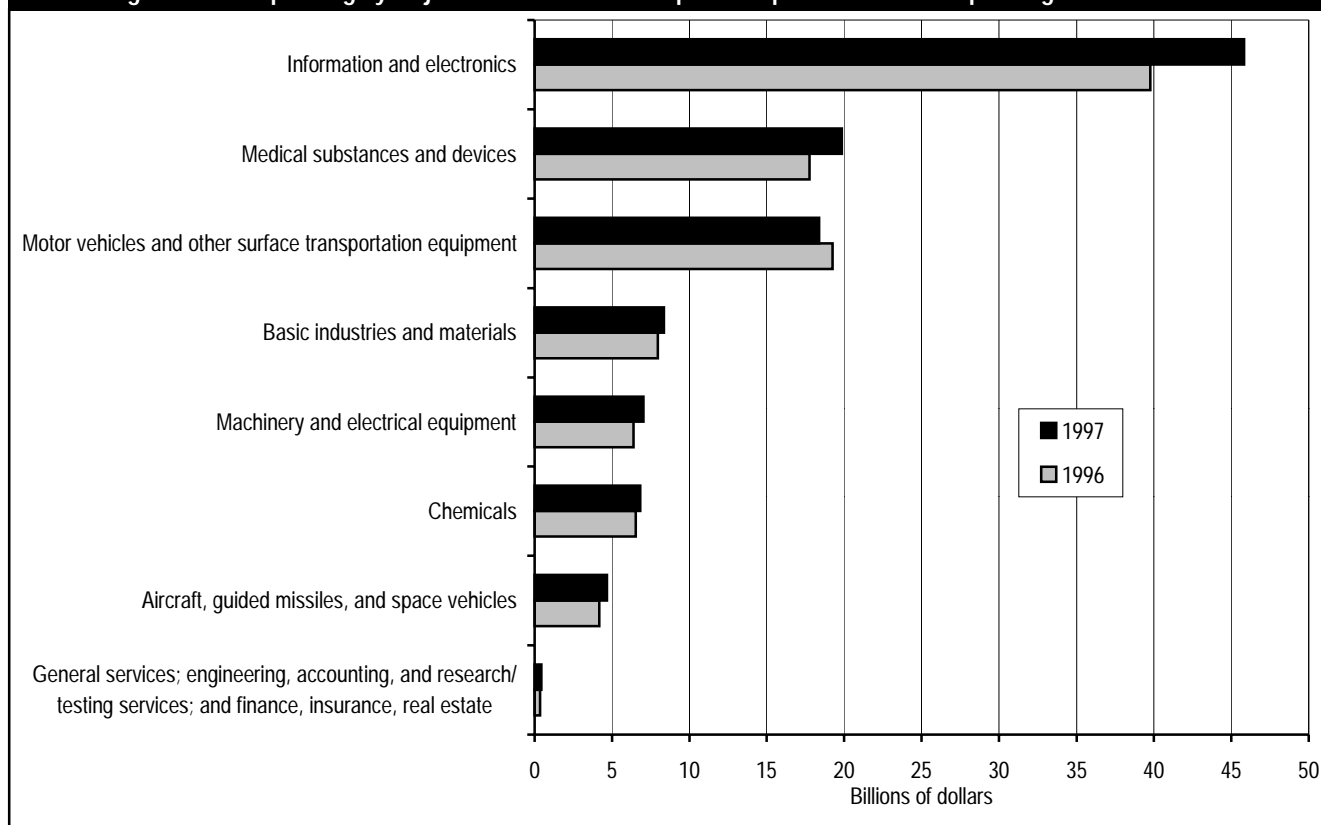
R&D SPENDING AND GROWTH RATE

Figures 1 and 2, respectively, display the total R&D spending and R&D spending growth rate of the top 500 corporations of 1996 and 1997. These R&D spending levels are grouped among eight major industrial sectors based on their standard industrial classifications and their conceptual similarities with regard to patterns of technological change. These categories are: information and electronics; medical substances and devices; motor vehicles and surface transportation; basic industries and materials; machinery and electrical equipment; chemicals; aircraft, guided missiles, and space vehicles; and all other industries. The all-other category contains only 10 of the top 500 1997 firms in R&D, and less than 0.5 percent of total R&D among those top 500 firms. This category includes general services; engineering, accounting and research/testing services; and finance, insurance, and real estate.³

Table 1 (page 21) provides the same aggregate information as figures 1 and 2, along with more detailed information on smaller industrial sectors. It also provides data on employment and sales in 1996 and 1997 in those detailed sectors. These data, however, pertain only to the top 500 corporations in R&D expenditures in each year.

Among the seven major sectors that conducted more than \$4 billion in R&D in 1997, the largest R&D sector, information and electronics, increased its annual R&D spending the most, 15.2 percent, to \$45.824 billion. The second largest R&D sector, medical substances and devices, raised its R&D spending 11.7 percent to \$19.849 billion, moving it ahead of the only declining R&D sector (between 1996 and 1997), motor vehicles and surface transportation, which reduced its spending 4.6 percent to \$18.380 billion. The smaller aircraft, guided

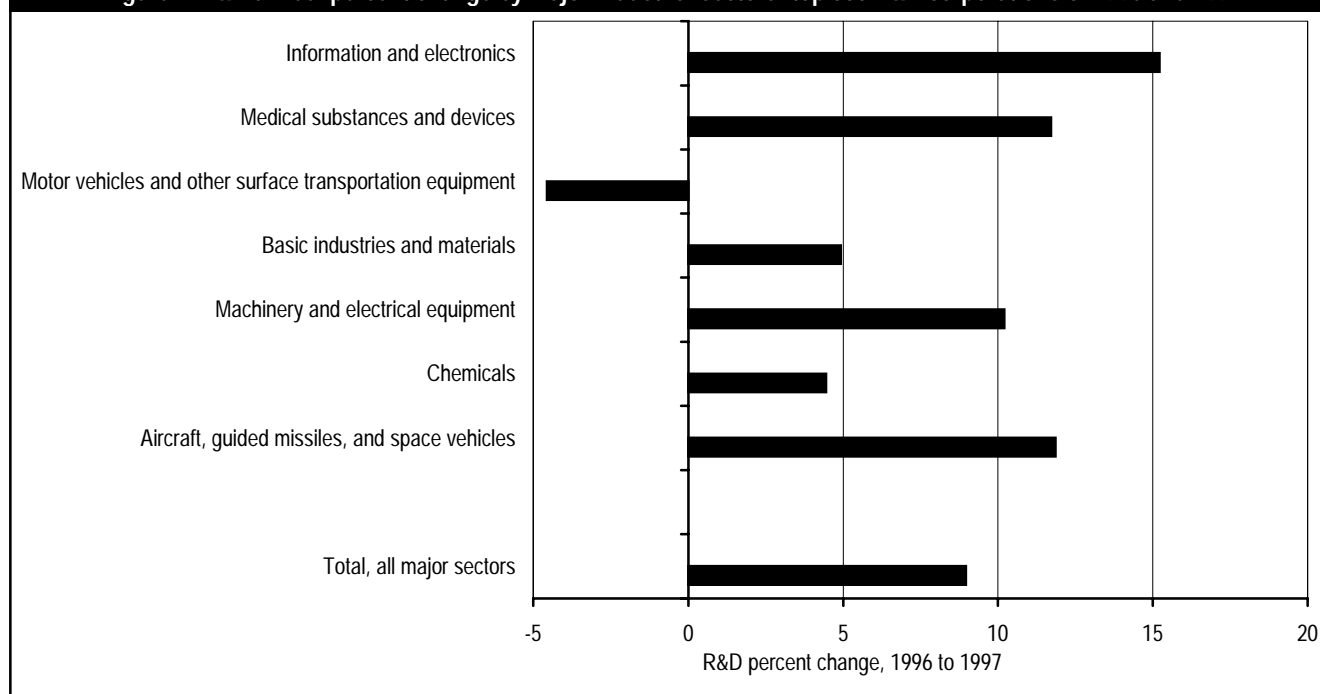
Figure 1. R&D spending by major industrial sectors: top 500 corporations in R&D spending of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

³ See tables 1-3 for more information on these sectors.

Figure 2. R&D annual percent change by major industrial sectors: top 500 R&D corporations of 1996 and 1997



NOTE: Totals include all 8 "major industrial sectors", including the sector "general services; engineering, accounting, and research/testing services; and finance, insurance, real estate. This last sector was not shown separately because of its small relative level of R&D.

SOURCE: Standard & Poor's Compustat, Englewood, CO

missiles, and space vehicles R&D sector experienced the second fastest surge in R&D spending, growing 11.9 percent to \$4.673 billion.

The R&D spending and R&D growth rates of the two largest major sectors, information and electronics and medical substances and devices, are broken down by detailed industry sector in figure 3. Within information and electronics, firms in the electronic computers and computer terminals industry spent the most on R&D in 1997, totaling \$11.094 billion, growing 10.1 percent over the previous year. Electronic components, which includes semiconductors, is the second largest R&D spender in the sector at \$6.648 billion, growing 17.3 percent, and followed closely by the third largest R&D spender, prepackaged software, which grew 25.7 percent. The impressive 39.2 percent R&D growth rate of the sixth largest R&D spending industry in the sector, computer networking communications equipment, reflects the phenomenal growth of computer network systems, including the Internet.

At 46.8 percent, the R&D spending growth of the fourth largest information and electronics industry—modems and other wired telephone equipment—is, in part, misleading because of a one-time shift in the reporting

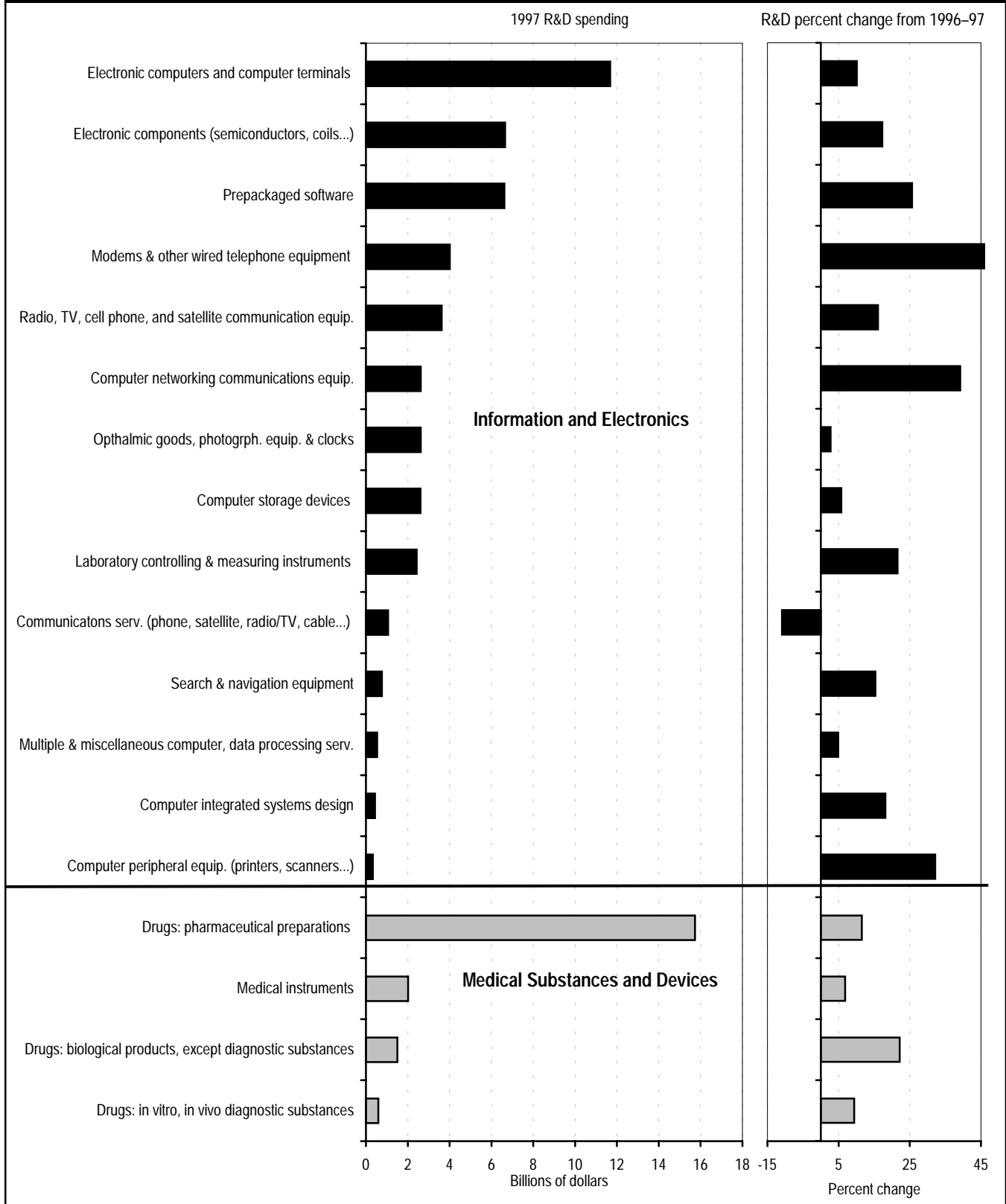
year of Lucent Technologies, Inc. Lucent Technologies accounts for 77.3 percent of that detailed sector's R&D spending. In 1996, Lucent Technologies changed its fiscal year-end from December 31 to September 30, consequently shortening its 1996 reporting year to only 9 months. This led to a reduction in the reported amounts of R&D spending in 1996 and other indicators to about three-quarters of what they would have been otherwise, thereby resulting in an artificially-inflated, reported growth rate between 1996 and 1997.

Within the medical substances and devices sector, pharmaceuticals preparations firms spent by far the largest amount on R&D, totaling \$15.733 billion in 1997, which was up 11.5 percent over 1996. Medical instruments firms spent a total of \$2.018 billion, 6.8 percent more than in 1996.

R&D INTENSITY

Figure 4 shows the combined R&D intensity of firms in each major industry sector. R&D intensity is the ratio of R&D to sales expressed as a percentage. In 1997, medical substances and devices firms had by far the highest combined R&D intensity at 11.8 percent, a

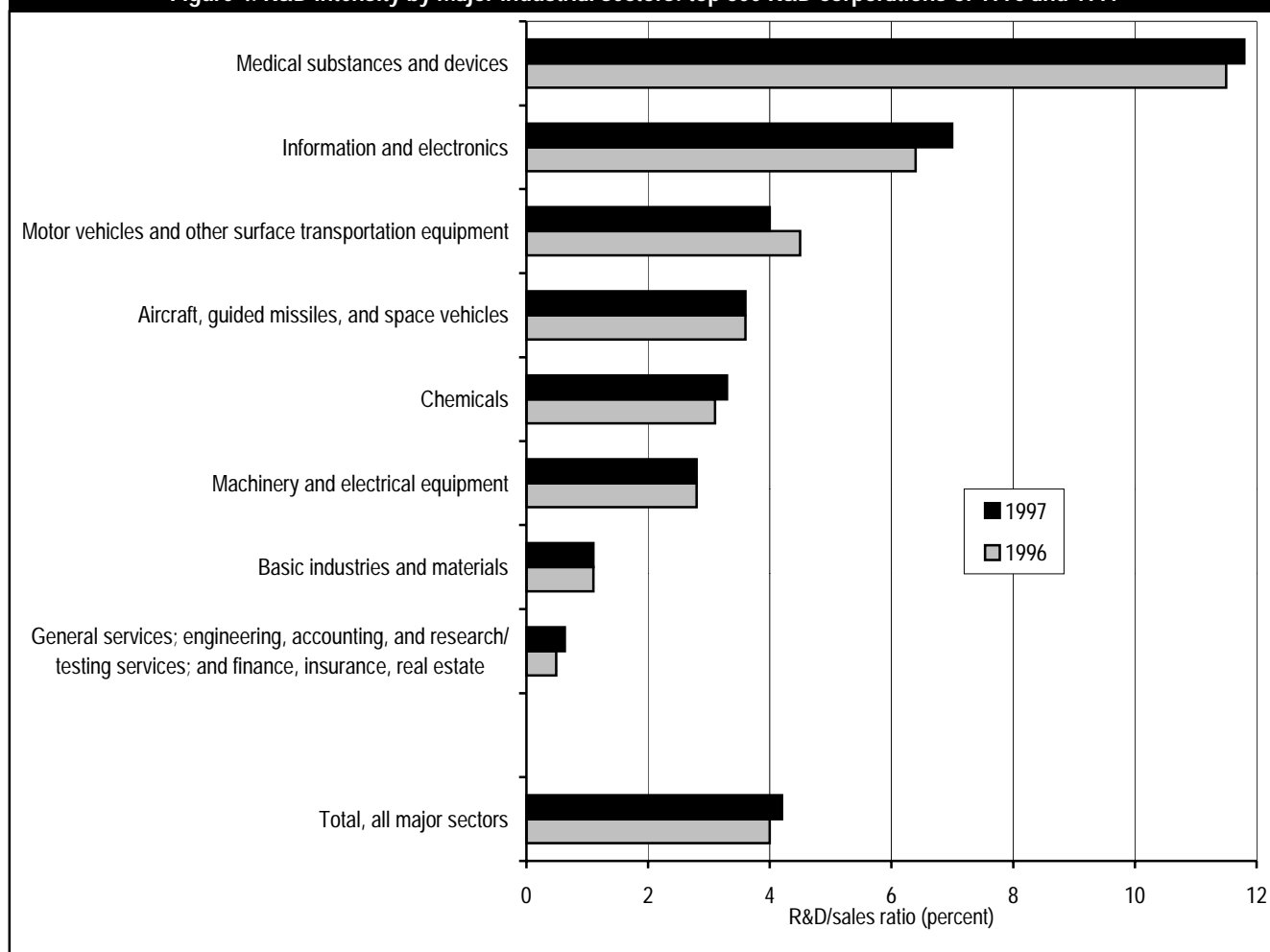
Figure 3. R&D spending and R&D growth of detailed industry sectors within the information and electronics sector and medical substances and devices sector



NOTE: The figure does not include the two smallest *information and electronics* industry sectors: (1) *household audio & video equipment, and audio recordings*, which spent \$230 million on R&D with a 73-percent R&D decline from the previous year; and (2) *calculating/accounting machines & office machines*, which spent \$210 million on R&D with a 2-percent growth in R&D.

SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 4. R&D intensity by major industrial sectors: top 500 R&D corporations of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

0.3-percentage point increase over 1996 and well above the 4.2-percent average for all 500 top 1997 R&D spenders combined. The information and electronics sector ranked second in intensity at 7.0 percent, an increase of 0.6-percentage points over 1996. Both these sectors increased their intensity due to increases in R&D spending rather than reductions in annual net sales.

As indicated in table 2 (page 23), the pattern of R&D spending per employee for the seven sectors is similar to that for R&D intensity with medical substances and devices, again the highest at \$29,095 per employee. Information and electronics is second at \$16,381.⁴ Combined, the top 500 1997 R&D firms spent \$10,457 per employee. Table 2 also provides R&D/sales ratios for major

and detailed sectors, as well as data on capital expenditure from 1996–97. Like table 1, table 2 is restricted to only the top 500 corporations in R&D expenditure.

While these R&D-to-sales ratios reflect the relative tendencies of companies to devote their own resources to R&D activities, they do not reflect the additional resources provided by the Federal Government (not included in this data series) that increase the actual amount of R&D performed. Such Federal support for R&D varies greatly by industry. Therefore, any study of the broader question of how much total R&D is performed by industry would require supplemental data on Federal support in addition to the data provided in this report.

⁴ See table 2 for industry figures on R&D spending per employee.

For example, according to the SRS findings, the Federal Government provided \$23.7 billion for industry R&D in 1996.⁵ Aerospace companies (or the industrial sector “aircraft and missiles”) alone received 44 percent of all Federal R&D funds provided to all industries. Consequently, 65 percent of the aerospace industry’s R&D dollars came from Federal sources, while the remaining 35 percent came from companies’ own funds. In comparison, the drugs and medicines sector in 1996 financed 100 percent of its R&D from company funds;⁶ machinery 99 percent; professional and scientific instruments 68 percent, transportation equipment other than aircraft and missiles 90 percent, business services 97 percent, and engineering and management services 62 percent.

R&D-to-sales ratios are known to reflect differences among industries in their relative reliance on R&D. However, comparisons between industries on this basis should be made cautiously, because, depending on the situation, the R&D-to-sales ratios may be as circumstantial as they are strategic. For example, in the case of the pharmaceutical industry, R&D is performed not only for the sake of discovering new products, but for the sake of product testing to meet regulatory requirements once a new product has been designed. A change in such regulatory requirements might, therefore, change the amount of R&D conducted without changing the number or value of new products being developed. Furthermore, for all industries, the cost of materials to the firm is included in the firm’s sales, even though that materials cost reflects the “sales” of another firm earlier in the production chain. As a result, firms further along the production chain will have higher sales, and thus lower reported R&D-to-sales ratios, even though R&D as a proportion of the firm’s contribution to GDP (as measured by value added) might not be any lower.

Finally, it is important to note that *U.S. Corporate R&D* does not distinguish between kinds of R&D by character of work (i.e., basic research, applied research, and development). According to other 1997 SRS data, more than two-thirds of U.S. industry R&D spending

consists of development. Of the remainder about 22 percent is applied research and less than 7 percent basic research. Significantly, spending on development contributed to almost all the robust growth in industry R&D during the 1990s. Contrarily, basic and applied research experienced substantial declines in the mid-1990s. While both kinds of R&D regained ground in the last half of the decade, by 1997 industry basic research spending had only recovered to 1991 levels in real terms. During the same period, modest growth in Federal spending on basic research (and to a lesser extent academic spending) ensured positive growth in the Nation’s overall investment in basic research.⁷

COMPARISON OF R&D SPENDING TO SALES, EMPLOYMENT, AND CAPITAL INVESTMENT

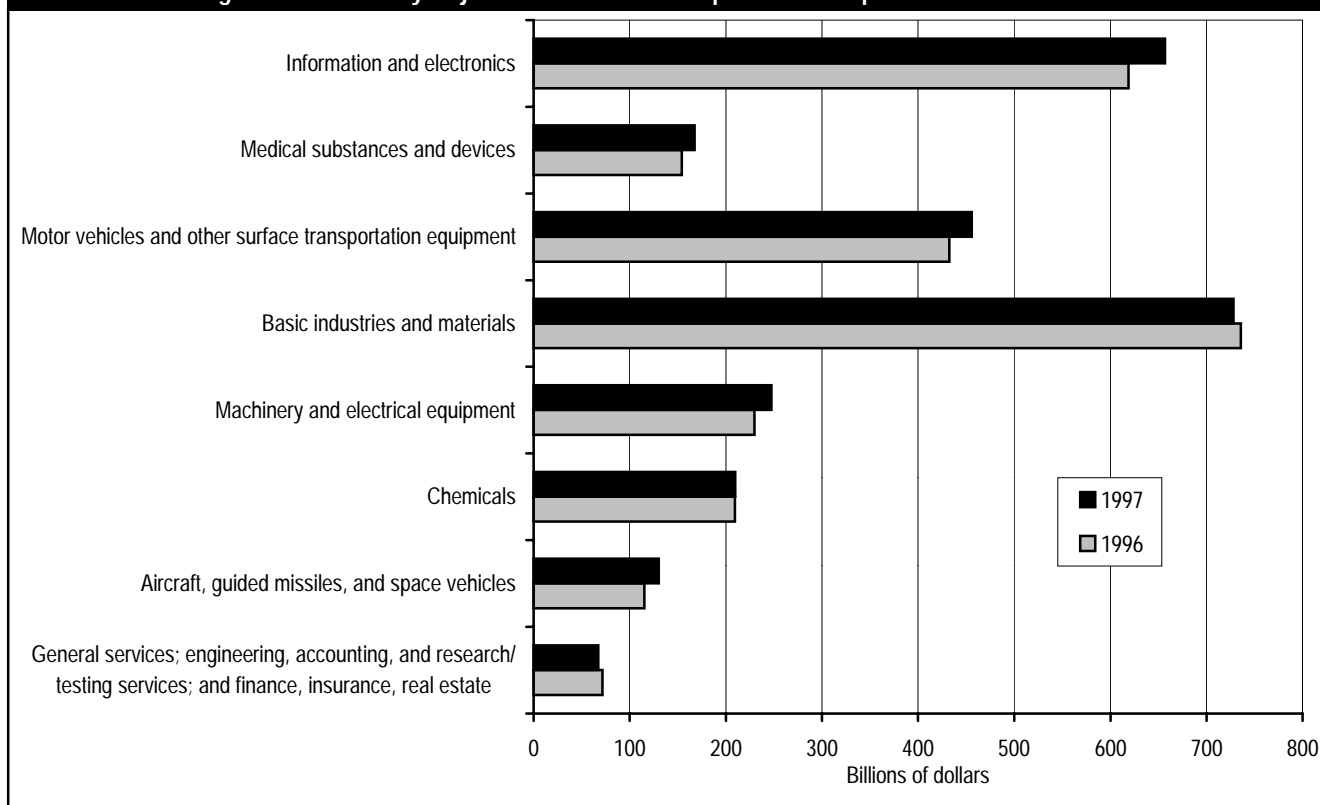
Figures 5, 6, and 7 reflect net sales, employment, and capital spending, respectively, for the major R&D sectors. Figure 8 reflects each sector’s percentage share of these three indicators, as well as R&D spending. In 1997, basic industries and materials led information and electronics in sales. But information and electronics employed more workers than other sectors, and edged out motor vehicles and surface transportation and basic industries and materials in capital spending. In considering these data, it is important to bear in mind that R&D, sales, employment, and capital spending totals of these industrial sectors reflect only the activity of the year’s top 500 R&D-spending corporations. Consequently, these data understate the aggregate R&D, sales, employment, and capital spending of the sectors examined. That is, sectors that have disproportionately fewer companies in the top 500 will tend to be understated more than other sectors. The most understated sectors in this respect are the basic industries and materials sector and the miscellaneous sector that includes general services, finance, insurance, etc. Nevertheless, for purposes of comparing the R&D-active portions of large corporations in all sectors, the data for these indicators are relevant.

⁵ National Science Foundation, *National Patterns of R&D Resources: 1998*, by Steven Payson, NSF 99-335 (Arlington, VA, 1999).

⁶ The 100-percent company funding for the drugs and medicines sector does not include support for R&D that NIH ultimately provides to this sector through its own research and through funding of research by universities and other organizations.

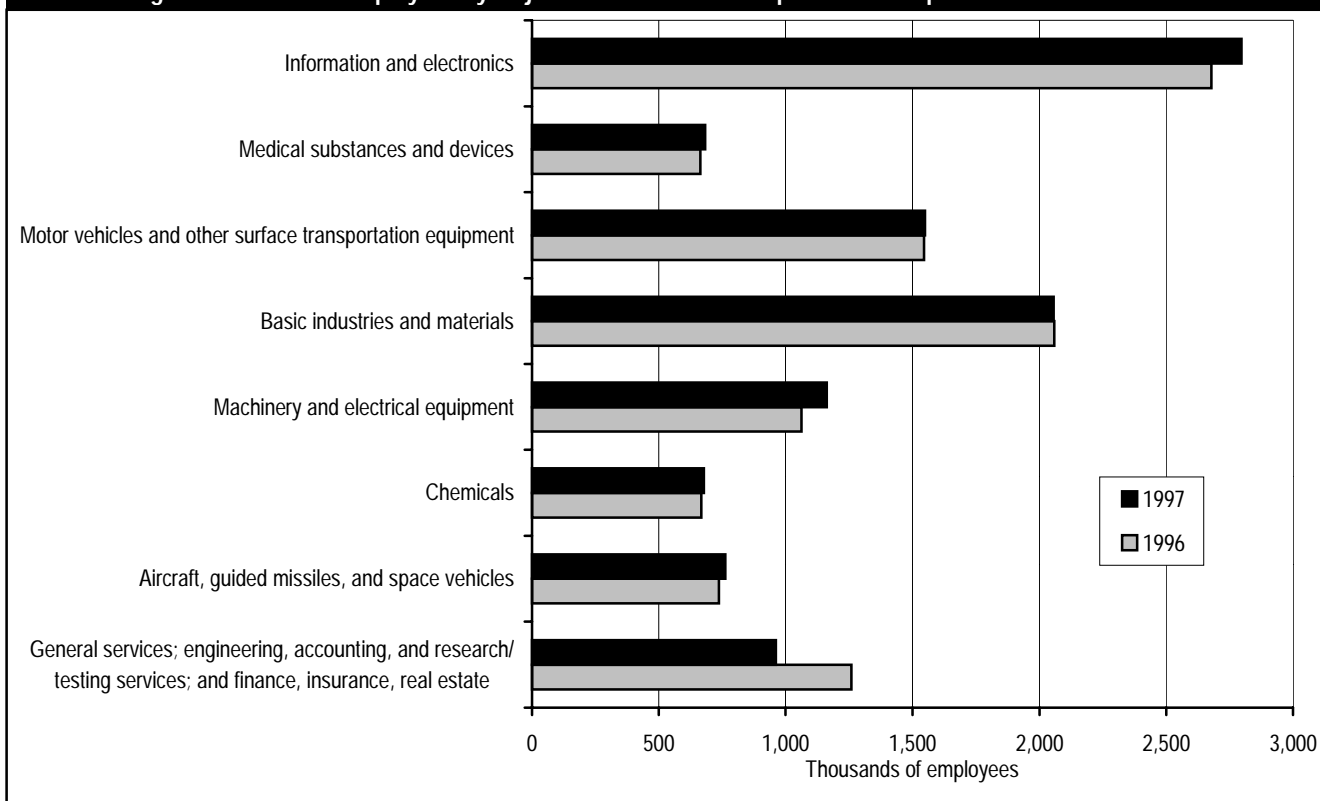
⁷ National Science Foundation, *National Patterns of R&D Resources: 1998*, by Steven Payson, NSF 99-335 (Arlington, VA, 1999).

Figure 5. Net sales by major industrial sectors: top 500 R&D corporations of 1996 and 1997



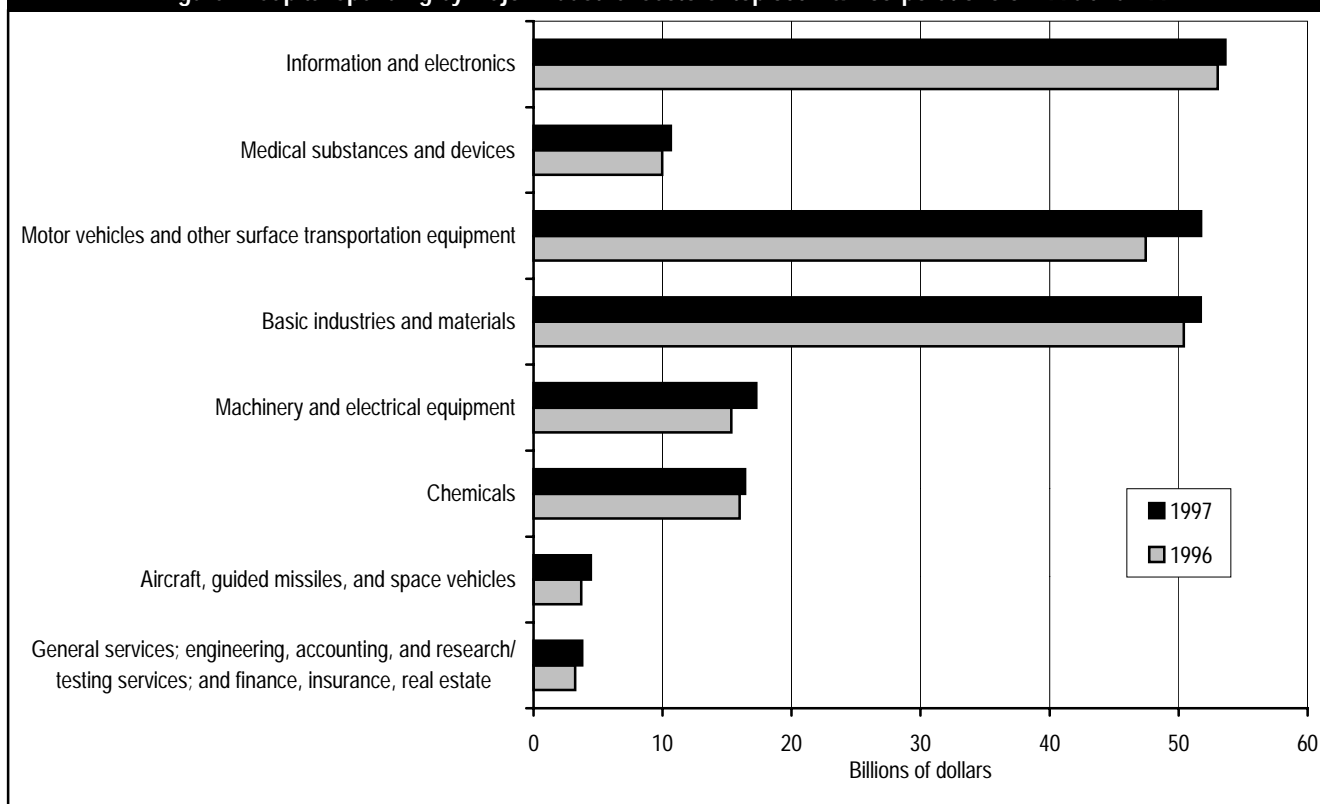
SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 6. Number of employees by major industrial sectors: top 500 R&D corporations of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 7. Capital spending by major industrial sectors: top 500 R&D corporations of 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

For the major R&D sectors, figure 9 compares the 1997 annual percent change in R&D spending to changes in net sales, capital spending, and employees. Total R&D of the seven major sectors grew by 9.0 percent between 1996 and 1997. This growth significantly out paces net sales (3.7 percent), capital investment (5.3 percent), and employment (a decline of 0.2 percent).

The comparison among the seven major R&D sectors, as shown in figure 9, with respect to the four indicators varies substantially. R&D growth out paces sales growth in five sectors. But it lags well behind sales in motor vehicles and surface transportation, and is slightly behind sales in the aircraft, guided missiles, and space vehicles. Capital spending growth exceeded R&D growth in three sectors: motor vehicles and surface transportation; machinery and electrical equipment; and aircraft, guided missiles, and space vehicles.

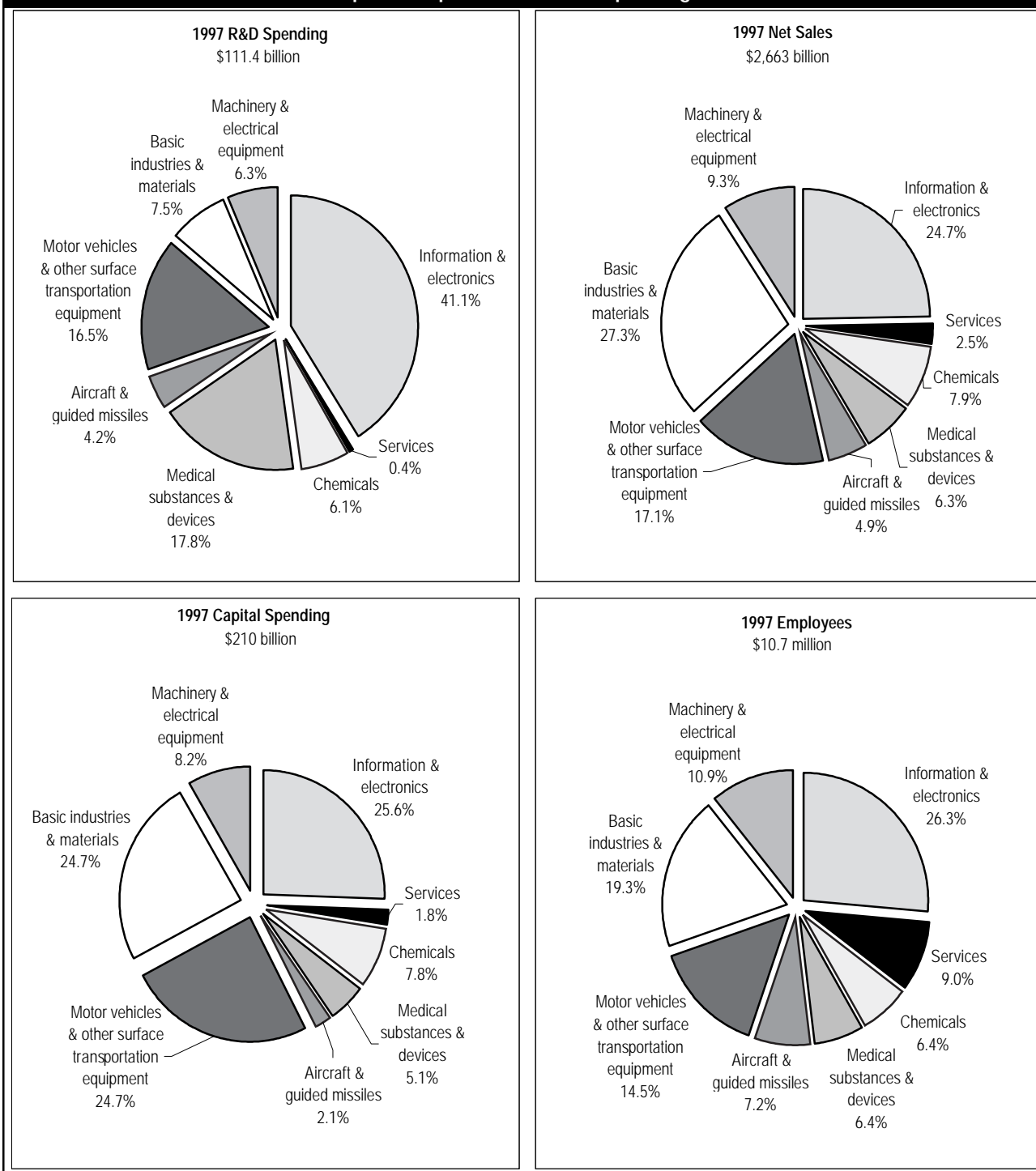
In general, high R&D growth sectors experienced stronger employment growth than sectors having slow R&D growth, although again, it is not possible to draw any connection between these variables from this limited data. Machinery and electrical equipment enjoyed the fastest employment growth at 9.4 percent, followed by

information and electronics at 4.4 percent and aircraft, guided missiles, and space vehicles at 3.5 percent. The slower growing R&D sectors, motor vehicles and surface transportation, and chemicals, experienced the lowest employment growth of the seven sectors, 0.2 percent and 1.6 percent, respectively.

COMPARISON OF GROWTH RATES IN R&D SPENDING & NET SALES

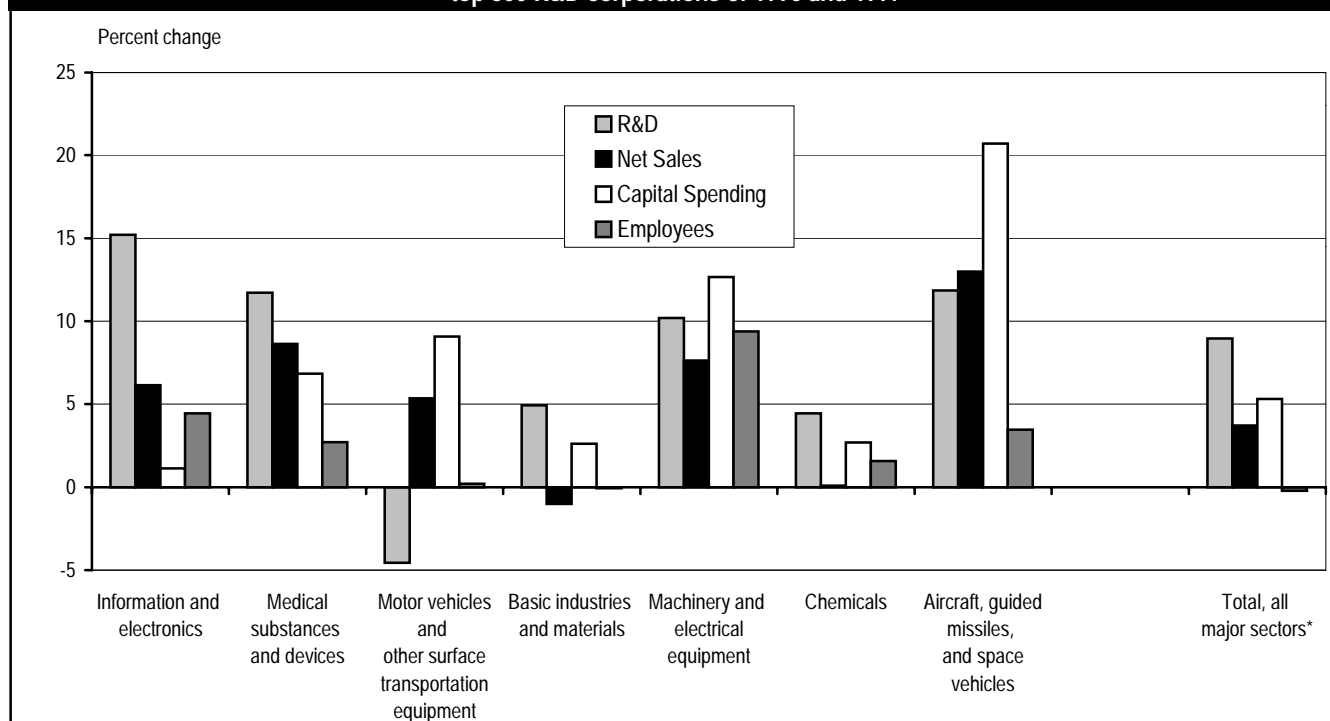
As shown in figure 10, which highlights the seven largest R&D sectors, R&D growth roughly correlates with sales growth in 1997. That is, growth in R&D spending tends to be higher for industries that have higher sales growth. Each sphere in figure 10 represents an industry. A close relationship would not be unexpected since the amount of company funds available for R&D investment often depends on the company's sales performance in the current and immediately preceding years. On the other hand, given that investment in R&D is frequently undertaken with the intention of eventually achieving higher sales, R&D investment may be as much a cause of sales growth as it is a result.

**Figure 8. Major industrial sector shares of R&D, sales, capital spending, and employment:
top 500 corporations in R&D spending for 1997**



SOURCE: Standard & Poor's Compustat, Englewood, CO

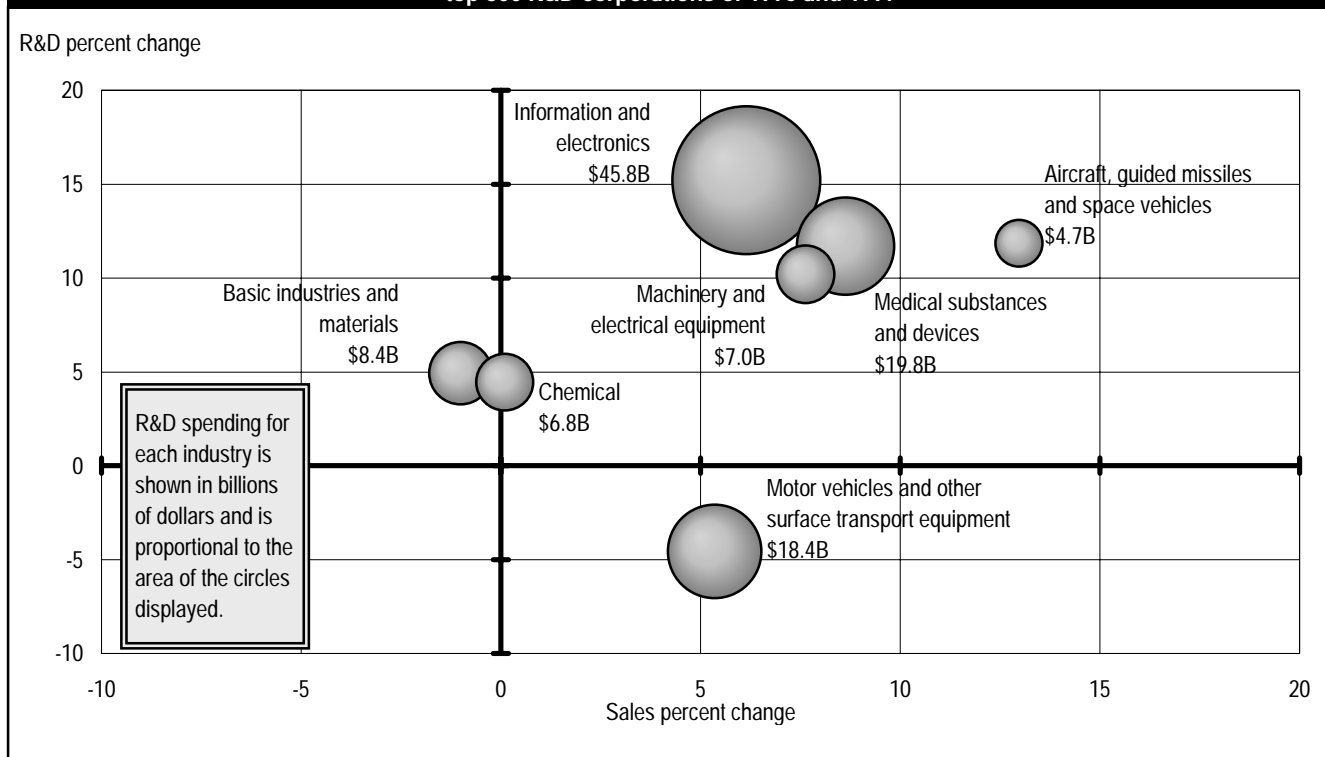
**Figure 9. Percent change between 1996 and 1997 in R&D spending, sales, capital spending, and employees by major industrial sector:
top 500 R&D corporations of 1996 and 1997**



*Totals include all 8 "major industrial sectors", including the sector "general services; engineering, accounting, and research/testing services; and finance, insurance, real estate. This last sector was not shown separately because of its small relative level of R&D.

SOURCE: Standard & Poor's Compustat, Englewood, CO

**Figure 10. Comparison of change in R&D and net sales between 1996 and 1997 and billions of R&D dollars per industry by major industrial sector:
top 500 R&D corporations of 1996 and 1997**



SOURCE: Standard & Poor's Compustat, Englewood, CO

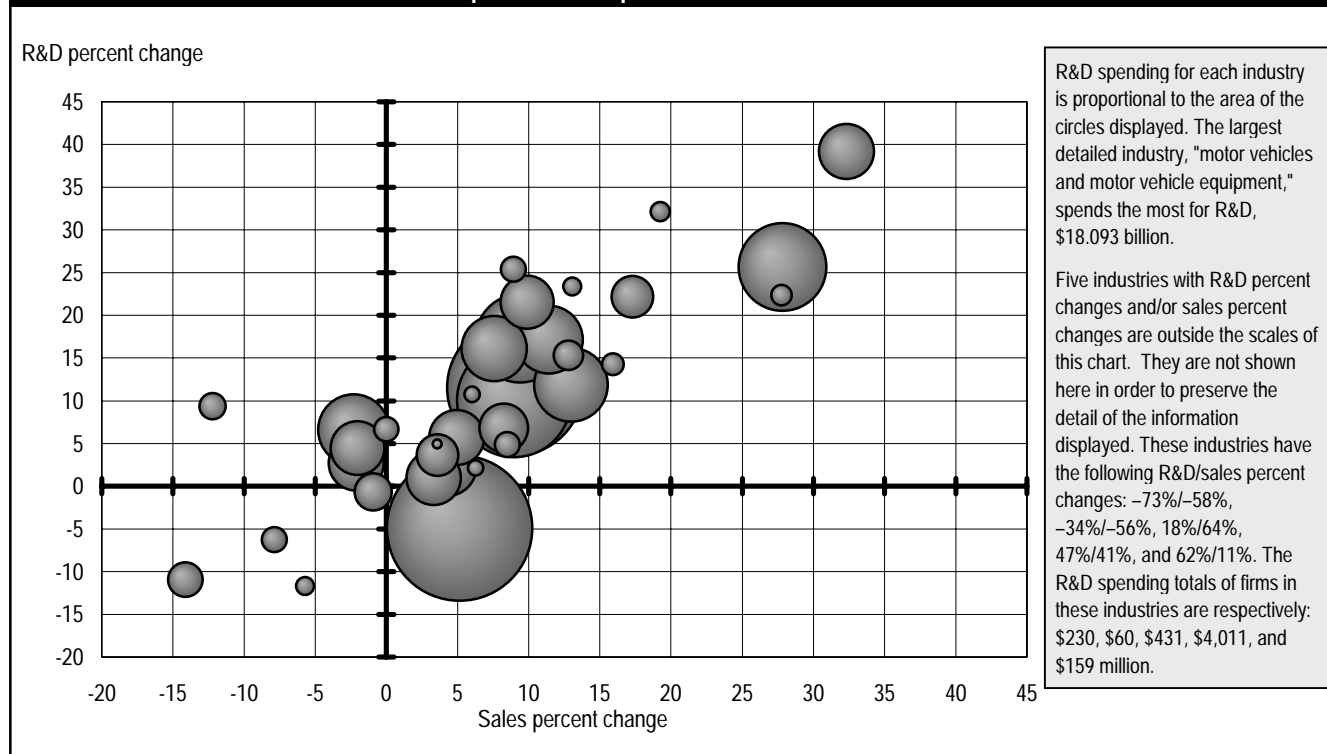
This relationship shows up more clearly in figure 11, which aggregates R&D spending and sales growth data for the top 500 companies of 1996 and 1997 into the 45 detailed sectors. In the figure, the various industries cluster along a diagonal line that runs from the lower left corner to the upper right corner. This clustering, which shows the positive relationship between R&D growth and sales growth, is also borne out by individual firm data for the top 500 firms.

DISTRIBUTION BY NUMBER AND SIZE OF FIRM

As shown in figures 12 and 13, respectively, the major industry sectors vary in number, as well as average sales of top 500 R&D-spending firms. At one extreme, aircraft,

guided missiles, and space vehicles, and motor vehicles and surface transportation, respectively, had 8 and 22 of the top 500 firms in 1997. The average net sales of firms in these two sectors were, respectively, \$16.286 billion and \$20.720 billion in 1997. At the other extreme, medical substances and devices and information and electronics, respectively, claimed 83 and 217 of the top 500 firms, but the net sales averages for firms in these sectors were relatively small, respectively, \$2.020 billion and \$3.027 billion in 1997. While these numbers reflect only the 500 largest of the more than 3,400 public firms whose R&D is reported in Compustat, they are significantly different enough to suggest that certain major R&D industry sectors have quite different industrial structures. As a consequence, the competitive conditions that influence firm R&D decisions and spending levels may also vary from one industry to another.

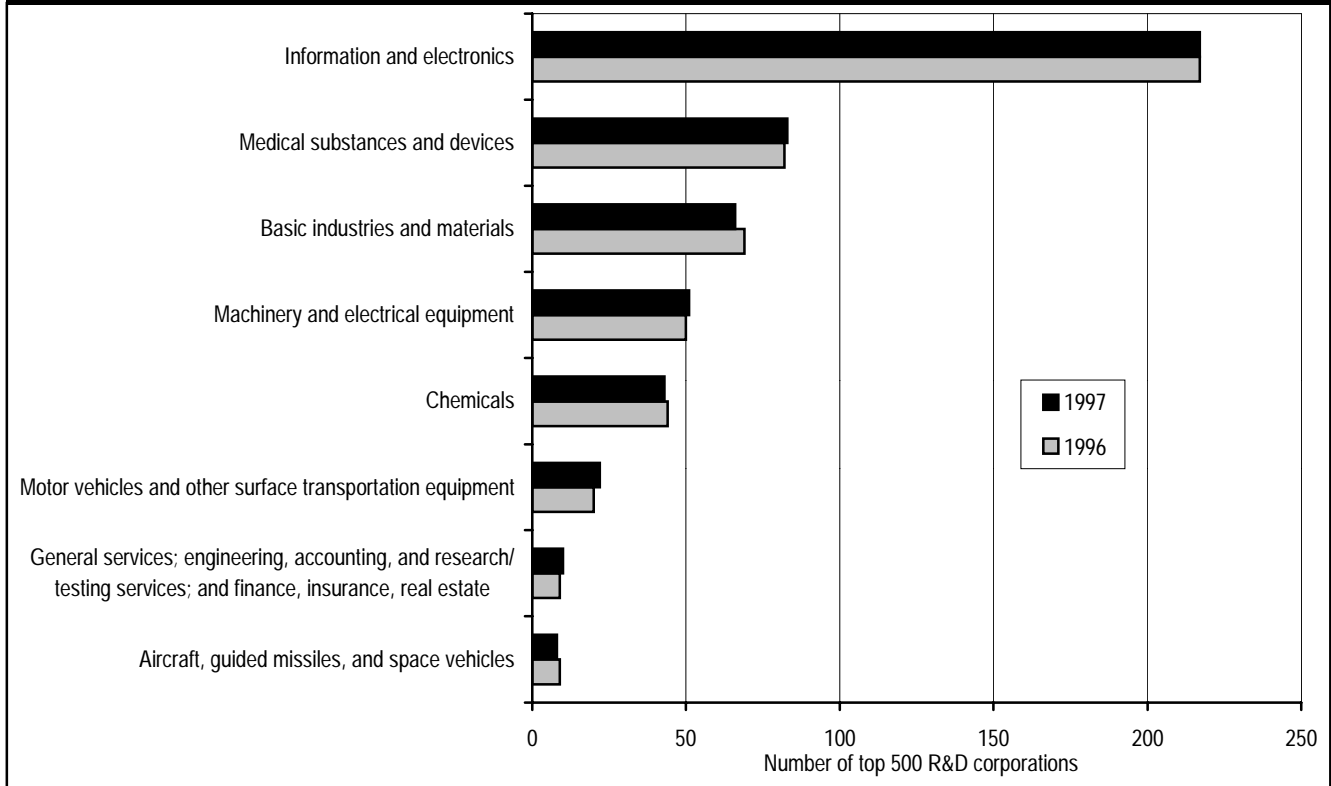
Figure 11. Comparison of change between 1996 and 1997 in detailed industries* R&D and net sales and billions of R&D dollars per detailed industry: top 500 R&D corporations of 1996 and 1997



*Except sectors in "engineering, accounting, and research/testing services," "finance insurance, real estate," and "general services."

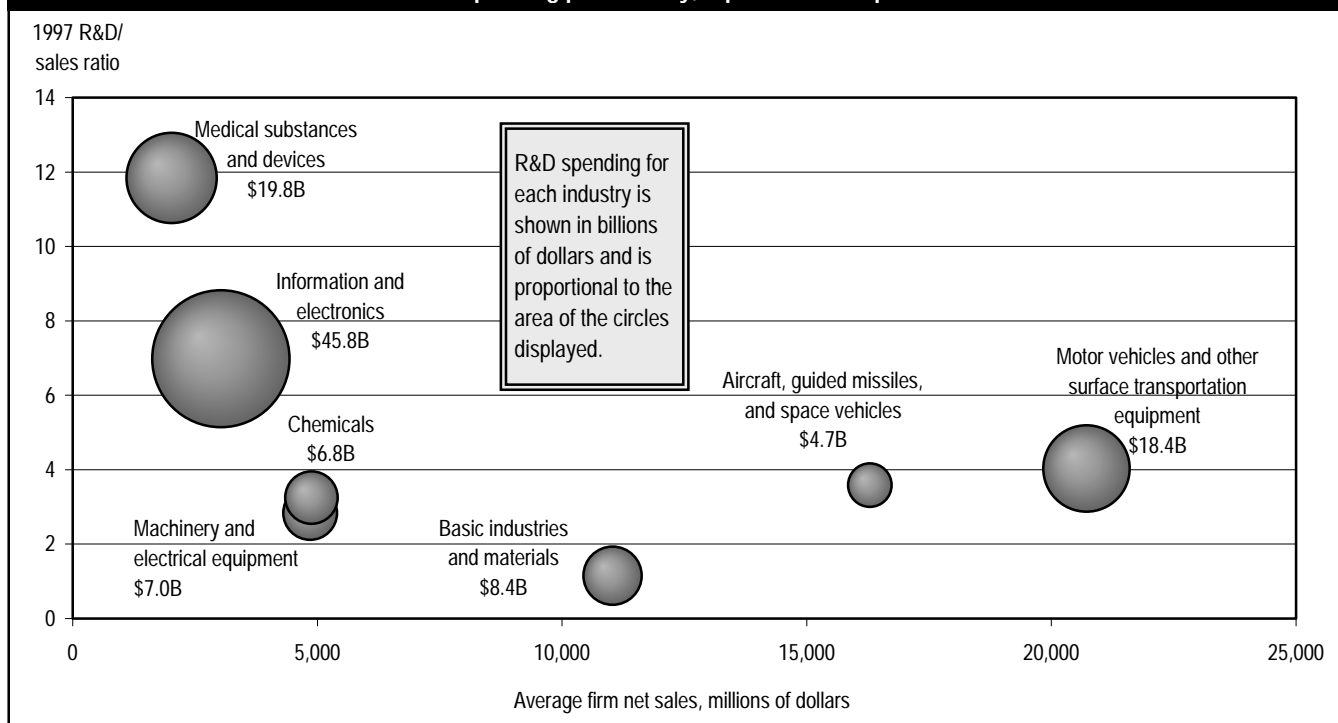
SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 12. Number of top 500 R&D corporations in major industrial sectors: 1996 and 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

Figure 13. R&D intensity compared to average firm net sales by major industrial sector
Billions of R&D spending per industry, top 500 R&D corporations of 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

PURPOSE AND CHARACTERISTICS OF THE DATA SERIES

The *U.S. Corporate R&D* data series supplements the NSF's SRS data series on U.S. industry R&D spending with timely information on both industrial sectors and individual firms. *U.S. Corporate R&D* is created under a joint agreement by U.S. Department of Commerce's OTP and the NSF's SRS. Based on Standard & Poor's *Compustat* database, the new data series features, for the years 1996 and 1997, the combined domestic and overseas R&D spending by the top 500 publicly held corporations headquartered in the United States. The data series provides not only individual firm and industry level R&D data, but also contextual data on net sales, capital spending, and employment.

CHARACTERISTICS OF THE SRS INDUSTRY R&D DATA SERIES

The long-established SRS data series on U.S. industry R&D and the *U.S. Corporate R&D* data series are distinctly different, but serve complementary needs. The SRS data series on industrial R&D provides national estimates of the expenditures on R&D performed within the United States by industrial firms, whether U.S. or foreign-owned. Designed to capture all industrial R&D performed domestically, the data series includes, but does not distinguish between, privately held and publicly held firms. In providing the most comprehensive data on U.S. domestic R&D spending, the data series necessarily precludes information on individual firm activity, since it uses confidential firm data provided to the Bureau of Census. The data series selectively excludes the R&D spending of U.S. companies overseas, which is published in a separate SRS data series on U.S. foreign subsidiaries.

Among the SRS data series statistics are estimates of total R&D, the portion financed by the Federal Government, and the portion financed by the companies themselves or by other non-federal sources, such as state and local governments or other industrial firms under contracts or subcontracts. Total R&D is also separated into its character-of-work components: basic research, applied research, and development. Other statistics include R&D financed by a domestic firm but performed outside the United States, R&D contracted to organizations outside of the firm, and the funds spent to perform energy-related R&D. The series also provides statistics

on domestic net sales, number of employees, number of R&D-performing scientists and engineers, and cost per R&D scientist and engineer.

These data are acquired through SRS's Survey of Industrial Research and Development. SRS has sponsored and managed surveys of industrial R&D since 1953. The content of these surveys has been expanded and refined over the years in response to an increasing need by policy makers for more detailed information on the nation's R&D effort. Beginning with the 1992 survey, the sample size was increased from approximately 14,000 to approximately 25,000 firms. This increase was made for several reasons: (1) to account better for births of R&D-performing firms in the survey universe; (2) to more fully and accurately survey R&D performed by non-manufacturing firms, especially in the service sector; and (3) to gather more current information about potential R&D performers.

CHARACTERISTICS OF THE *U.S.* *CORPORATE R&D* DATA SERIES

Because it is derived from Standard and Poor's *Compustat*, *U.S. Corporate R&D* meets a variety of analytic needs different from those provided by the Census-based SRS industry R&D data series. For example, tallies of latest year R&D spending data are available for firms very soon after the close of their fiscal year. By July of each year, *Compustat* compiles the latest R&D figures for a majority of the 9,800 active U.S. companies in its database. While *U.S. Corporate R&D* represents a smaller number of R&D firms than the SRS data series, it is sufficiently large and overlapping to help substantiate SRS R&D spending estimates issued earlier in the year for the most recently completed year. Furthermore, because *Compustat* provides data on other performance indicators for hundreds of individual firms (e.g., sales, employment, exports, foreign sales, and profits), the data series contains information that provides immediate context for analyses of industry R&D activity. Possible relationships between R&D spending and a wide variety of factors can be explored, the outcomes of which may be useful to researchers and policy makers. In addition, because it includes publicly held firms, *U.S. Corporate R&D* can provide R&D spending and other data for

SOME STRUCTURAL DIFFERENCES BETWEEN THE *U.S. CORPORATE R&D* AND THE SRS DATA SERIES

- The SRS data series includes privately held firms, whereas, *U.S. Corporate R&D* does not.
- Firms switching from private to public ownership may enter the *U.S. Corporate R&D* 500 top firms. Switches in ownership status do not influence the SRS data series
- In contrast to the SRS data series, *U.S. Corporate R&D* generally attributes R&D expense to the firm that is the research funding source, not the performer of the research (i.e., not contractors).
- The SRS data series includes R&D conducted in the United States by firms headquartered outside the United States, whereas *U.S. Corporate R&D* excludes such R&D.
- The R&D expenses of foreign firms that are acquired by U.S.-headquartered firms may be added to the *U.S. Corporate R&D* top 500 firm total. Conversely, U.S.-headquartered firms that are acquired by foreign-headquartered firms are no longer included in the top 500. The SRS data series is unaffected by change in national affiliation of a given firm or subsidiary conducting R&D in the United States.
- The SRS data series excludes U.S. firm R&D conducted abroad, while *U.S. Corporate R&D* includes it.
- The SRS data series includes the R&D expenditures of banks, utilities, and property and casualty companies, while *U.S. Corporate R&D* does not.

individual firms that often can be linked with other data series, thereby allowing for more detailed analysis of U.S. industrial R&D.

THE SOURCE DATABASE—*COMPUSTAT*:

U.S. Corporate R&D is derived from Standard and Poor's *Compustat* database, which provides 20 years of annual and monthly data and 48 quarters of quarterly data for more than 18,500 U.S. and Canadian companies.⁸ Of these firms, more than 9,800 are active U.S. companies (of which more than 3,400 conduct R&D) and approximately 8,200 are no longer active U.S. companies (due to buyouts, bankruptcy, etc.). *Compustat* provides R&D data for corporations, and also provides other financial, statistical, and market data for corporations, banks, savings and loans, business segments, geographic areas, industry composites, aggregates, and indexes. It provides coverage of annual and quarterly Income Statement, Balance Sheet, Statement of Cash Flows, and supplemental data items on publicly-held companies.

Compustat company data are derived from publicly held companies, specifically those trading on the New York Stock Exchange, American Stock Exchange, National Association of Securities Dealers Automated Quotations (NASDAQ), Over-the Counter, three Canadian stock exchanges, and wholly owned subsidiaries of companies that are required to file with the SEC.

The convention used by *Compustat* to adjust for the fact that the fiscal years of individual U.S. firms vary, is to treat fiscal years ending January 1 through May 31 as ending in the prior calendar year. Thus, the data for a fiscal year beginning on June 1, 1997 and ending on May 31, 1998 are reported as the year 1997, whereas data for a fiscal year beginning on July 1, 1997 and ending on June 30, 1998, are reported as the year 1998.

COMPUSTAT TREATMENT OF R&D EXPENSES

Because *Compustat* draws its R&D data from the 10-K reports that corporations file with the SEC, it relies fundamentally on the SEC's definition of R&D. It defines R&D expenditure as all costs incurred during the year, by the company in question, that relate to the research and development of new products, processes, or services. Such expenditures generally include related software expenses and amortization of software costs. They generally exclude the following items: (1) customer or government-sponsored R&D (including reimbursable

⁸ While *Compustat* provides data on a limited number of foreign firms, another comparable Standard and Poor's database, *Global Vantage*, is the primary source of information for these firms.

STATISTICAL COMPARISONS BETWEEN THE U.S. CORPORATE R&D AND THE SRS DATA SERIES

Table 3 (page 25) and figure 14 compare 1997 R&D spending data from the *U.S. Corporate R&D* and SRS industry survey. Differences in the R&D spending of various industrial sectors are attributable to the smaller universe of firms in *U.S. Corporate R&D*, as well as, the structural differences between the two data series discussed in the text box on the previous page.

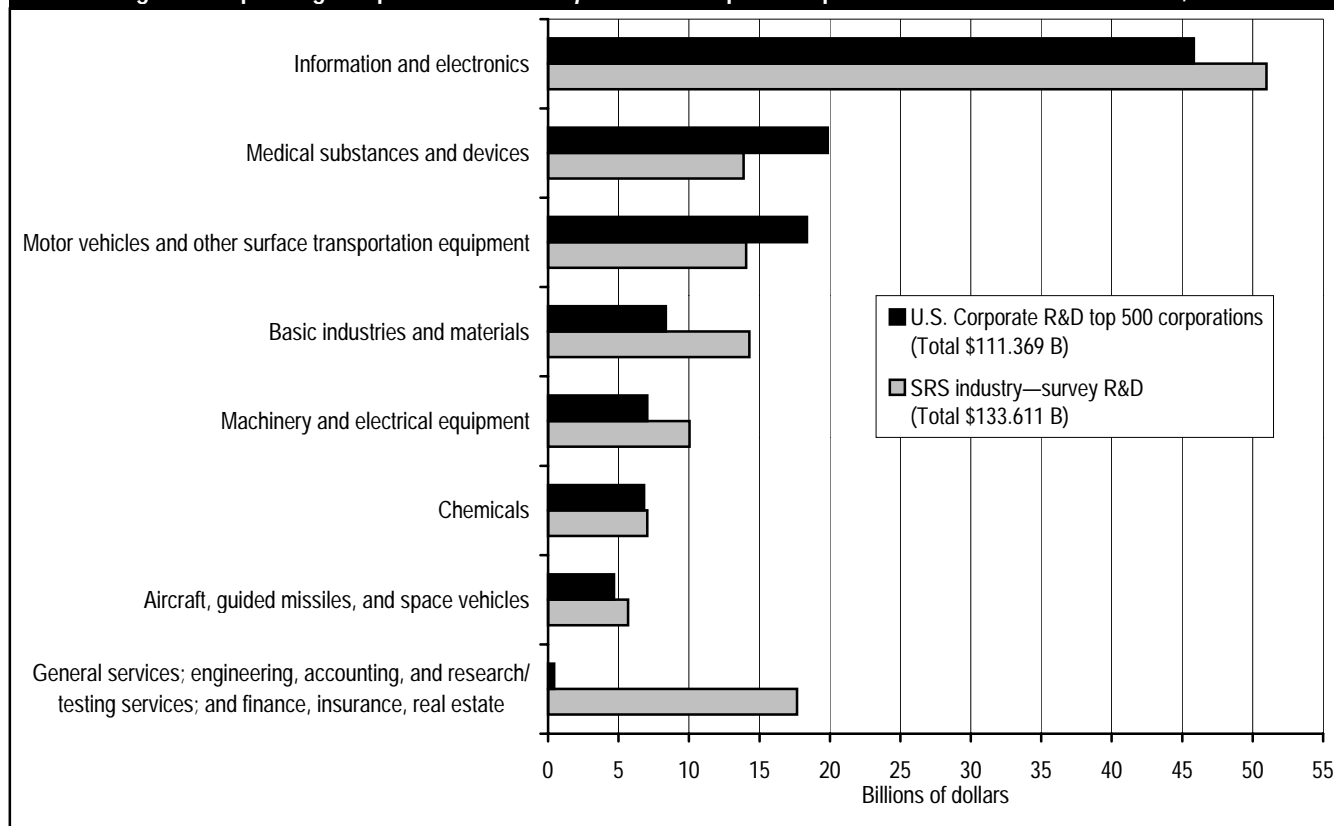
The *U.S. Corporate R&D* total of \$111 billion for the top 500-R&D spenders in 1997 is 83.4 percent of the SRS industry survey estimate of \$134 billion—about what might be expected given differences in the two series. According to the SRS industry survey, R&D increased by 10.4 percent over the survey's \$121 billion total, in comparison to a 9.0-percent increase according to the *U.S. Corporate R&D* data series. *U.S. Corporate R&D* aggregates for the following four major industries also compare reasonably to corresponding SRS survey aggregates: aircraft, guided missiles, and space vehicles (82.3 percent of SRS data); chemicals (96.9 percent); information and electronics (89.9 percent); and machinery and electrical equipment (70.1 percent).

Nevertheless, within information and electronics, the *U.S. Corporate R&D* and the SRS industry survey assign quite different R&D spending amounts for various detailed industries. For example, according to *U.S. Corporate R&D*, the five computer-related hardware detailed sectors together spent a total of \$16.9 billion, compared to the SRS survey's \$12.8 billion. Conversely, *U.S. Corporate R&D* attributes \$6.6 billion to electronic components, while SRS assigns \$10.8 billion. Such differences between the two series within information and electronics may be due largely to differences in how *Compustat* and the U.S. Census Bureau assign Standard Industrial Codes to firms.

U.S. Corporate R&D attributes significantly higher amounts of R&D spending than SRS to two major sectors, motor vehicles and surface transportation and the large “substances” portion of medical substances and devices—respectively, 130.7 and 153.9 percent of the SRS amount. One possible explanation for these differences may be that U.S. firms in these industries spend greater amount for R&D abroad than do their foreign counterparts in the United States. Another explanation may obtain from the fact that SRS assigns R&D spending to the R&D performer (e.g. contractors), whereas, *U.S. Corporate R&D* attributes the R&D spending to the funding source. Accordingly, significant amounts of motor vehicle research may be under contract to some of the many firms in other sectors that provide motor vehicle subcomponents. In the case of medical substances, the SRS survey may view a sizable amount of that industry's R&D as occurring under contract in testing/research services. This “transfer” of R&D funds may also partly explain why *U.S. Corporate R&D* attributes a much smaller portion of R&D to testing/research services than does SRS (in addition to the fact that many testing and research service firms may be too small for inclusion in top 500 *U.S. Corporate R&D* firms).

The significantly smaller amount of R&D spending that *U.S. Corporate R&D* attributes to the basic industries and materials sector may be partly because SRS includes many more smaller and private firms. This same factor may contribute also to the very significant lower *U.S. Corporate R&D* amounts attributed to the finance, insurance, real estate, and general services sectors. Additionally, the amount of R&D attributed by *U.S. Corporate R&D* to these last two sectors is reduced by the fact that *Compustat* does not report the R&D expenditures of banks, utilities, and property and casualty companies.

Figure 14. Spending comparison of U.S. Corporate R&D top 500 corporations and the SRS Data Series, 1997



SOURCE: Standard & Poor's Compustat, Englewood, CO

indirect costs);⁹ (2) extractive industry activities, such as prospecting, acquisition of mineral rights, drilling, mining, etc.; (3) those engineering expenses directed toward routine, ongoing efforts to define, enrich, or improve the qualities of existing products; (4) inventory royalties; and (5) marketing research and testing. R&D expense is not itemized with respect to banks, utilities, or property and casualty companies.

Compustat's SEC-based definition of R&D is the same as the SRS definition with two exceptions. First, unlike SRS, *Compustat's* SEC-based data does not exclude social science research. Second, following SEC rules, *Compustat* data does not include very small R&D amounts that are not material to a firm's decision-making. These differences in definition are unlikely to contribute to any significant differences.

Greater differences, however, may result from the fact that some firms consider certain routine engineering activities as qualified research for inclusion

⁹ Given the latitude that exists in firms reporting such information, this may not always be the case, e.g., some firms probably do report federally supported R&D as their own, especially when such support is provided after the R&D was actually performed, as in the case of Federal support for independent R&D.

on SRS industry R&D questionnaires, but do not report such activity as R&D to the SEC, which disallows it.¹⁰

The fact that *Compustat* only includes a given firm's own expenditure on R&D is significant. This means *Compustat* usually attributes R&D funds to the research-funding source, not the final performer of research when it is contracted out to another firm. As a result, reported levels of R&D by industry group are different from what they would be if they were based on the actual locations of final R&D activities. For example, if a manufacturing firm purchases the services of a research and testing firm, those expenses are generally reported under "manufacturing R&D" rather than "services-sector R&D," although the latter would better reflect where R&D is actually performed.

For each firm *Compustat* provides only a single annual R&D expense total. Thus, unlike some other data in *Compustat*, such as net sales, data on separate R&D expenses for a single firm are not available for R&D performed in different geographic regions, such as in the United States

¹⁰ Bronwyn Hall and William F. Long, "Difference in Reported R&D Data on the NSF/Census RD-1 Form and the SEC 10-K Form: A Micro-Data Investigation," unpublished report to the National Science Foundation, April 1998.

or performed abroad by U.S.-owned subsidiaries. Only a single, combined R&D total is provided for each firm.

TOP 500 R&D SPENDERS

Based on their latest annual R&D spending, *U.S. Corporate R&D* identifies the top 500 R&D-conducting, publicly held corporations that are headquartered in the states or territories of the United States.¹¹ The data series excludes the R&D of U.S. subsidiaries owned by corporations headquartered in foreign countries. The top 500-R&D firms in *U.S. Corporate R&D* account for nearly 90 percent of all the R&D spending reported by *Compustat* from more than 3,000 firms. Because the list of top 500-R&D corporations changes from year to year, *U.S. Corporate R&D* uses two distinct 1996 and 1997 lists of top 500 firms for generating and comparing aggregate 1996 and 1997 activity.

Annual changes in the corporate composition and overall R&D content of the top 500 firms in *U.S. Corporate R&D* may be attributed to a variety of factors, such as: (1) firms increasing or decreasing their ordinary and usual R&D expenses as necessary; (2) firms merging or spinning off (such as Lucent from AT&T); (3) U.S.-headquartered firms acquiring other U.S.-headquartered firms, private firms, or foreign firms; (4) private U.S. firms becoming publicly held; and (5) foreign headquartered firms acquiring U.S.-headquartered firms, in which case the latter's R&D is no longer tracked.

INDUSTRIAL SECTORS

U.S. Corporate R&D categorizes individual firms and relates R&D data according to eight "major" industrial sectors and 45 "detailed" industrial sectors. The detailed sectors are similar, but not identical to sectors featured by the SRS data series.¹² The eight major sectors combine detailed sectors into some new, large industrial groups, one of which, information and electronics, includes both

manufacturers and services (communications and software). By categorizing many multifaceted firms into broad industrial categories, these large sectors minimize the misleading effects of labeling firms by a narrower Standard Industrial Code (SIC) and the movement of R&D from one narrow category to another when companies acquire (or spin-off) companies into a different sector. Seven of these eight major sectors conduct significant amounts of R&D and/or include significant numbers of R&D firms among the top 500-R&D spending corporations. The remaining sector—general services; engineering, accounting, and research testing services; finance, insurance and real estate—contains only 10 of the top 500 1997 R&D firms in the *Compustat*, accounting for less than 0.5 percent R&D performed by the top 500.

While generally reflective of the activity or performance in a given sector, sectoral aggregates (including R&D, sales, and employment) should be used with caution. Because *U.S. Corporate R&D* data are tabulated at the enterprise level, all the R&D or other activity pertaining to a single firm are attributed to the major (most relevant) SIC of that firm. This means all the R&D of a given firm is classified under one SIC regardless of how many other SICs may apply to various firm activities and subdivisions. Industrial sector aggregates thus contain activities of many firms and subdivisions that logically should, but cannot be, attributed to other sectors.

Another reason for caution in using sectoral aggregates is that, from year to year, aggregates may rise or fall not only due to trends in the industries themselves, but also due to the acquisition of firms or subsidiaries by other firms. When such acquisitions occur within a single industrial sector, they do not affect year-to-year aggregates. However, aggregates may be significantly affected when major mergers or acquisitions cross industrial sectors. For example, the manufacturing sector was enlarged at the expense of the service sector when IBM acquired Lotus in 1995. Similarly, the spin-off of Lucent from AT&T in 1995 reassigned very significant amounts of R&D from the communications services sector to the communications equipment sector.

R&D VALUATION ADJUSTMENTS

The *U.S. Corporate R&D* data series aims at using a firm's internal, current dollar expenditures to measure actual performance of R&D work (i.e., scientists and engineers doing work on research and development projects). However, when one firm acquires another, *Compustat* generally combines the acquiring firm's internal R&D

¹¹ The list of 500 companies is drawn from *Compustat* data reported on July 31, 1998. While *Compustat* reports latest year data for nearly all large firms by July 31, *Compustat* reports a significant number of smaller firms over the remainder of the calendar year. Some of these late firms may have R&D spending levels equal to or greater than some firms contained in the July 31 list of top 500 R&D spenders.

¹² While the detailed industrial sectors of *U.S. Corporate R&D* and the SRS data series are similar, differences exist in the method of classifying firms by category. Most importantly, in some cases the same firm may be grouped under different industrial categories by the two data series, thereby limiting the comparability of the two series in terms of industry aggregates.

expenditure with write-offs of purchased in-process R&D (IPR&D) and reports these as a single R&D expense. This practice presents difficulties for the *U.S. Corporate R&D* data series. This is because it mixes together acquired R&D, which is often measured according to some estimate of its future value, with R&D that is measured strictly by the current expenditure of dollars.¹³

¹³ This distinction arises from existing accounting rules and related policy questions regarding the appropriate valuation of purchased in-process R&D (IPR&D), and the consistency of accounting treatment between IPR&D and an acquiring firm's own internal R&D expenditure. According to 1974 rules of the Financial Accounting Standards Board (FASB), R&D conducted internally should be expensed rather than capitalized (FASB Statement No. 2: *Accounting for Research and Development Costs*). In a later interpretation, the Board additionally determined that certain forms of R&D that might transfer in a corporate acquisition could also be expensed, including "even a specific research project in process." The extent of the write-off should be determined "from the amount paid by the acquiring enterprise and not from the original cost to the acquired enterprise." The amounts allocated to IPR&D are expensed at the date of consummation of the acquisition, unless the projects have an alternative future use.

In the last several years, amounts attributed to purchased IPR&D have increased, raising questions as to whether the valuations are measuring the fair value of the IPR&D. By increasing IPR&D, acquiring firms reduce their reported levels of assets attributable to goodwill and other intangibles, and thereby improve their returns on equity. While the write-offs reduce net earnings in the year of purchase, they also bolster future earnings, an important gauge to investors of a firm's health. Such write-offs, which are intended to represent the fair value of the acquired in-process technology, may be significantly larger than the amount originally spent on R&D by the acquired firm.

Under generally accepted accounting principles (GAAP), goodwill is the remaining value of a company's purchase price after accounting for acquired tangible and identified intangible assets such as IPR&D. Generally, firms wish to avoid recording large amounts of goodwill since it is amortized over its useful life, using periods as long as 40 years, during which earnings per share are reduced annually. Also, most securities analysts subtract goodwill from equity when examining a firm debt-to-equity position.

In a number of high-profile acquisitions, the purchasing firms have written off significant portions of acquisition cost as IPR&D. For example, in 1995 when IBM purchased Lotus Development Corporation it valued the acquired R&D as \$1.800 billion, increasing IBM's total *Compustat* reported R&D from \$3.382 billion in 1994 to \$5.227 billion. Prior to its acquisition, Lotus reported an R&D expenditure of only \$256 million. Similarly, in 1994 and 1995, acquisitions by Computer Associates resulted in the write off of significant portions of acquisition costs as IPR&D, with the result that its *Compustat* reported total R&D increased from \$226 million in 1993 to \$504 million in 1994, and to \$1.607 billion in 1995. The practice is not limited to the purchase of software companies; any company with products under development may have IPR&D to be written off.

As more companies in recent years have written off acquired IPR&D, the Securities & Exchange Commission (SEC) has increased its scrutiny of company IPR&D valuations, and in several cases has forced companies to reduce their write-offs. In addition, the FASB has indicated that it will examine the appropriate accounting treatment for both in-house and acquired R&D.

In order to eliminate potential overstatement of actual R&D expenses, the *U.S. Corporate R&D* series adjusts *Compustat*-reported R&D expenses when IPR&D write-offs do not represent actual dollars spent on R&D in the current year. Firms that may have such write-offs are identified by a combination of filters that look for unusual increases in R&D from year to year, or significant differences in annual percent changes between R&D and net sales, or R&D and employment. The SEC submissions of identified firms are then examined to determine whether an unusual R&D increase is due to either an exceptionally large increase in actual R&D performance or to the write-off of purchased IPR&D.

These screening and adjusting methodologies are not perfect. Some firms are examined based on past activity or other information. However, not all smaller firms are examined and the modest percentage increases of larger firms may contain relatively small IPR&D write-offs. Also, firms that may in the same year write off large amounts of IPR&D and significantly decrease their spending on actual R&D may not be identified, thereby leaving their R&D expenses subsequently unadjusted.

Table 1. Comparison of 1996 and 1997 R&D, employment, and sales of top 500 corporations in R&D, by detailed sector

Page 1 of 2

Major & detailed industrial sector	R&D			Total Employment			Total Sales		
	(in thousands of dollars)		As a percent of the total 500 in 1997	Percent change from 1996-97	Number of employees	Percent change from 1996-97	(in thousands of dollars)		
	1996	1997					1996	1997	
All of the top 500 firms (across all industries)	102,212,335	111,368,541	100.00	8.96	10,673,673	10,650,175	2,567,942,770	2,663,277,692	3.71
Aircraft, guided missiles, & space vehicles	4,177,500	4,672,800	4.20	11.86	736,783	762,298	115,323,800	130,291,000	12.98
Basic industries & materials	7,963,432	8,355,329	7.50	4.92	2,057,850	2,056,390	735,636,514	728,194,509	-1.01
Agr. services; forestry: fishing; mining; construction.....	183,600	203,300	0.18	10.73	6,620	7,031	2,108,500	2,235,400	6.02
Fabricated metal products, except machinery & transp. eq.....	476,244	508,038	0.46	6.68	176,762	172,812	31,237,141	31,236,739	0.00
Food & kindred products; tobacco products.....	1,195,600	1,187,900	1.07	-0.64	457,534	441,424	120,006,208	118,903,836	-0.92
Lumber, wood products, & furniture.....	433,083	543,085	0.49	25.40	162,303	185,603	31,877,279	34,722,299	8.92
Misc. products (leather, toys, jewelry, musical inst.).....	304,429	372,432	0.33	22.34	41,800	42,262	7,521,780	9,610,072	27.76
Printing, publishing, & allied industries.....	98,413	159,472	0.14	62.04	19,388	21,447	3,582,035	3,958,203	10.50
Stone, clay, glass, & concrete products.....	360,791	412,266	0.37	14.27	80,900	90,200	13,354,200	15,479,542	15.92
Textile & apparel products.....	73,449	77,091	0.07	4.96	10,454	10,681	1,792,945	1,857,134	3.58
Oil & gas extraction; petrol. refining & related ind.	2,367,808	2,474,105	2.22	4.49	494,235	509,180	402,872,740	394,692,040	-2.03
Paper & allied products.....	1,462,562	1,515,944	1.36	3.65	287,587	292,113	63,499,747	65,776,346	3.59
Ferrous metal products.....	91,200	60,300	0.05	-33.88	41,500	22,000	8,494,600	3,745,100	-55.91
Nonferrous metal products.....	324,503	286,676	0.26	-11.66	126,231	117,002	26,194,306	24,699,228	-5.71
Rubber & misc. plastic prod. (tires, plastic footwear...).....	591,750	554,720	0.50	-6.26	152,536	144,635	23,095,033	21,278,570	-7.87
Chemicals	6,531,070	6,821,613	6.13	4.45	667,231	677,803	209,481,018	209,664,483	0.09
Industrial chem.; plastic & other synthetic materials.....	4,029,550	4,295,342	3.86	6.60	315,419	312,391	120,452,214	117,681,699	-2.30
Other chem. (soaps, ink, paints, fertilizers, explosives...).....	2,501,520	2,526,271	2.27	0.99	351,812	365,412	89,028,804	91,982,784	3.32
Engineering, accounting, & research/testing services	125,341	138,309	0.12	10.35	25,800	52,300	2,922,852	5,624,956	92.45
Finance, insurance, real estate	47,863	81,048	0.07	69.33	1,411	3,505	301,510	1,362,427	351.87
General services	180,118	207,689	0.19	15.31	1,232,349	905,843	68,547,624	60,376,709	-11.92
Other (noncomputer) bus. serv (advertising, equip. rental...).....	25,394	52,582	0.05	107.06	543	1,620	1,669	76,449	4480.53
Transportation; freight & warehousing; & pipeline services.....	55,500	68,000	0.06	22.52	885,871	892,873	56,402,000	58,216,000	3.22
Wholesale & retail trade.....	99,224	87,107	0.08	-12.21	345,935	11,350	12,143,955	2,084,260	-82.84

See SOURCE at end of table

Table 1. Comparison of 1996 and 1997 R&D, employment, and sales of top 500 corporations in R&D, by detailed sector

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Major & detailed industrial sector	R&D			Employment			Sales			Percent change from 1996-97
	(In thousands of dollars)		As a percent of the total 500 in 1997	(Number of employees)		Percent change from 1996-97	(In thousands of dollars)			
	1996	1997		1996	1997		1996	1997		
Information & electronics	39,774,093	45,823,950	41.15	2,678,550	2,797,403	4.44	618,813,972	656,846,593	6.15	
Calculating/accounting mach. & office machines, nec.	206,063	210,468	0.19	42,315	43,869	3.67	6,257,579	6,650,241	6.27	
Communications serv. (phone, satellite, radio/TV, cable...)	1,182,833	1,053,727	0.95	302,156	244,448	-19.10	87,070,125	74,768,322	-14.13	
Computer integrated systems design	364,923	431,256	0.39	21,546	33,090	53.58	3,483,351	5,706,732	63.83	
Computer networking communications equip.	1,882,810	2,620,503	2.35	36,212	42,863	18.37	15,756,577	20,849,561	32.32	
Computer peripheral equip. (printers, scanners...)	246,176	325,349	0.29	14,162	14,294	0.93	4,003,665	4,774,453	19.25	
Computer storage devices	2,466,070	2,607,477	2.34	186,431	211,348	13.37	38,747,320	40,661,287	4.94	
Electronic components (semiconductors, coils...)	5,668,425	6,648,235	5.97	321,588	340,356	5.84	66,209,820	72,429,514	9.39	
Electronic computers & computer terminals	10,077,693	11,093,953	9.96	508,192	558,862	9.97	176,569,828	192,432,594	8.98	
Household audio & video equipment, & audio recordings	835,871	229,751	0.21	110,269	34,784	-68.46	18,420,195	7,801,494	-57.65	
Laboratory controlling & measuring instruments	1,993,705	2,423,390	2.18	221,193	257,279	16.31	34,187,521	37,567,392	9.89	
Modems & other wired telephone equipment	2,732,411	4,010,990	3.60	156,116	167,125	7.05	23,960,981	33,740,146	40.81	
Multiple & miscellaneous computer & data processing services	515,211	540,442	0.49	42,470	42,567	0.23	6,345,929	6,885,293	8.50	
Optthalmic goods, photograph. equip. & clocks	2,546,710	2,616,313	2.35	216,101	223,806	3.57	40,448,717	39,586,587	-2.13	
Prepackaged software	5,266,971	6,619,062	5.94	136,782	160,331	17.22	34,517,217	44,120,965	27.82	
Radio, TV, cell phone, & satellite communication eq.	3,122,671	3,625,457	3.26	204,617	215,681	5.41	38,360,636	41,264,513	7.57	
Search & navigation equipment	665,550	767,577	0.69	158,400	206,700	30.49	24,474,511	27,607,499	12.80	
Machinery & electrical equipment	6,387,141	7,038,500	6.32	1,063,117	1,162,838	9.38	229,905,228	247,446,687	7.63	
Electrical equipment (industrial & household)	3,000,095	3,070,656	2.76	519,786	532,873	2.52	121,703,964	126,878,992	4.25	
Machinery (indus., farm, services, mining & construction)	3,387,046	3,967,844	3.56	543,331	629,965	15.94	108,201,264	120,567,695	11.43	
Medical substances & devices	17,767,772	19,849,094	17.82	664,202	682,214	2.71	154,312,901	167,633,078	8.63	
Drugs: biological products, except diagnostic substances	1,231,684	1,504,594	1.35	12,411	15,235	22.75	3,501,925	4,106,957	17.28	
Drugs: in vitro, in vivo diagnostic substances	542,086	592,959	0.53	19,033	15,606	-18.01	3,521,965	3,091,440	-12.22	
Drugs: pharmaceutical preparations	14,105,088	15,733,395	14.13	499,680	514,369	2.94	125,973,138	137,359,581	9.04	
Medical instruments	1,888,914	2,018,146	1.81	133,078	137,004	2.95	21,315,873	23,075,100	8.25	
Motor vehicles & other surface transportation equipment	19,258,005	18,380,209	16.50	1,546,380	1,549,581	0.21	432,697,351	455,837,250	5.35	
Ships, trains, motorcycles, bicycles, campers, military tanks	232,470	286,808	0.26	72,870	85,060	16.73	11,380,938	12,868,704	13.07	
Motor vehicles & motor vehicle equipment	19,025,535	18,093,401	16.25	1,473,510	1,464,521	-0.61	421,316,413	442,968,546	5.14	

KEY: nec -- Not elsewhere classified

SOURCE: Standard and Poor's Compustat, Englewood, CO.

Table 2. Comparison of 1996 and 1997 capital expenditure, R&D/sales ratio, and R&D/employment ratio of top 500 corporations in R&D, by detailed sector

Page 1 of 2

Major & detailed industrial sector	Capital expenditure			R&D/sales ratio		R&D/employment	
	1996	1997	Change from 1996-97	1996	1997	1996	1997
	(In thousands of dollars)		(Percent)	(Percent)		(Dollars per employee)	
Top 500 corporations (across all industries)	199,057,903	209,635,382	5.31	3.98	4.18	9,576	10,457
Aircraft, guided missiles & space vehicles	3,686,100	4,449,900	20.72	3.62	3.59	5,670	6,130
Basic industries & materials	50,392,908	51,713,149	2.62	1.08	1.15	3,870	4,063
Agr. services; forestry; mining; construction.....	146,700	186,400	27.06	8.71	9.09	27,734	28,915
Fabricated metal products, except machinery & transp. eq.....	2,044,074	2,076,520	1.59	1.52	1.63	2,694	2,940
Food & kindred products; tobacco products.....	4,939,533	4,664,939	-5.56	1.00	1.00	2,613	2,691
Lumber, wood products, & furniture.....	2,079,671	1,439,200	-30.80	1.36	1.56	2,668	2,926
Misc. products (leather, toys, jewelry, musical inst.).....	382,531	421,955	10.31	4.05	3.88	7,283	8,812
Printing, publishing, & allied industries.....	272,158	395,504	45.32	2.75	4.03	5,076	7,436
Stone, clay, glass, & concrete products.....	1,434,758	1,598,779	11.43	2.70	2.66	4,460	4,571
Textile & apparel products.....	108,767	113,793	4.62	4.10	4.15	7,026	7,218
Oil & gas extraction; petrol. refining & related ind.....	30,542,101	33,025,107	8.13	0.59	0.63	4,791	4,859
Paper & allied products.....	4,908,441	5,102,898	3.96	2.30	2.30	5,086	5,190
Ferrous metal products.....	347,600	96,300	-72.30	1.07	1.61	2,198	2,741
Nonferrous metal products.....	1,768,670	1,370,489	-22.51	1.24	1.16	2,571	2,450
Rubber & misc. plastic prod. (tires, plastic footwear...).....	1,417,904	1,221,265	-13.87	2.56	2.61	3,879	3,835
Chemicals	15,979,555	16,409,997	2.69	3.12	3.25	9,788	10,064
Industrial chem.; plastic & other synthetic materials.....	10,907,622	11,681,488	7.09	3.35	3.65	12,775	13,750
Other chem. (soaps, ink, paints, fertilizers, explosives...).....	5,071,933	4,728,509	-6.77	2.81	2.75	7,110	6,913
Engineering, accounting, & research/testing services	133,190	163,012	22.39	4.29	2.46	4,858	2,645
Finance, insurance, real estate	37,133	258,815	596.99	15.87	5.95	33,921	23,124
General services	3,061,709	3,339,130	9.06	0.26	0.34	146	229
Other (noncomputer) bus. serv (advertising, equip. rental...).....	44,956	62,998	40.13	1521.51	68.78	46,766	32,458
Transportation; freight & warehousing; & pipeline services.....	2,339,600	3,233,000	38.19	0.10	0.12	63	76
Wholesale & retail trade.....	677,153	43,132	(93.63)	0.82	4.18	287	7,675

See SOURCE at end of table

Table 2. Comparison of 1996 and 1997 capital expenditure, R&D/sales ratio, and R&D/employment ratio of top 500 corporations in R&D, by detailed sector

Page 2 of 2

Major & detailed industrial sector	Capital expenditure			R&D/sales ratio		R&D/employment	
	1996	1997	Change from 1996-97	1996	1997	1996	1997
	(In thousands of dollars)	(In thousands of dollars)	(Percent)	(Percent)	(Percent)	(Dollars per employee)	(Dollars per employee)
Information & electronics	53,018,113	53,624,756	1.14	6.43	6.98	14,849	16,381
Calculating/accounting mach. & office machines, nec.....	362,873	374,291	3.15	3.29	3.16	4,870	4,798
Communications serv. (phone, satellite, radio/TV, cable...).....	13,555,977	12,676,013	-6.49	1.36	1.41	3,915	4,311
Computer integrated systems design.....	130,094	380,542	192.51	10.48	7.56	16,937	13,033
Computer networking communications equip.	1,126,597	913,803	-18.89	11.95	12.57	51,994	61,137
Computer peripheral equip. (printers, scanners...).....	221,473	167,816	-24.23	6.15	6.81	17,383	22,761
Computer storage devices.....	2,004,239	2,076,732	3.62	6.36	6.41	13,228	12,337
Electronic components (semiconductors, coils...).....	11,985,814	11,249,167	-6.15	8.56	9.18	17,626	19,533
Electronic computers & computer terminals.....	9,964,264	11,491,962	15.33	5.71	5.77	19,830	19,851
Household audio & video equipment, & audio recordings.....	1,053,054	1,035,678	-1.65	4.54	2.94	7,580	6,605
Laboratory controlling & measuring instruments.....	1,547,567	1,665,022	7.59	5.83	6.45	9,013	9,419
Modems & other wired telephone equipment.....	1,603,558	2,199,054	37.14	11.40	11.89	17,502	24,000
Multiple & miscellaneous computer & data processing services.....	404,093	414,479	2.57	8.12	7.85	12,131	12,696
Ophthalmic goods, photograph. equip. & clocks.....	2,278,349	2,391,037	4.95	6.30	6.61	11,785	11,690
Prepackaged software.....	2,099,650	2,074,568	-1.19	15.26	15.00	38,506	41,284
Radio, TV, cell phone, & satellite communication eq.....	3,945,943	3,659,526	-7.26	8.14	8.79	15,261	16,809
Search & navigation equipment.....	734,568	855,066	16.40	2.72	2.78	4,202	3,713
Machinery & electrical equipment	15,337,480	17,281,298	12.67	2.78	2.84	6,008	6,053
Electrical equipment (industrial & household).....	10,548,717	10,702,407	1.46	2.47	2.42	5,772	5,762
Machinery (indus., farm, services, mining & construction).....	4,788,763	6,578,891	37.38	3.13	3.29	6,234	6,299
Medical substances & devices	9,966,717	10,648,623	6.84	11.51	11.84	26,751	29,095
Drugs: biological products, except diagnostic substances.....	462,530	564,931	22.14	35.17	36.64	99,241	98,759
Drugs: in vitro, in vivo diagnostic substances.....	308,176	207,474	-32.68	15.39	19.18	28,481	37,996
Drugs: pharmaceutical preparations.....	7,890,949	8,372,782	6.11	11.20	11.45	28,228	30,588
Medical instruments.....	1,305,062	1,503,436	15.20	8.86	8.75	14,194	14,731
Motor vehicles & other surface transportation equipment	47,444,998	51,746,702	9.07	4.45	4.03	12,454	11,861
Ships, trains, motorcycles, bicycles, campers, military tanks.....	542,560	556,665	2.60	2.04	2.23	3,190	3,372
Motor vehicles & motor vehicle equipment.....	46,902,438	51,190,037	9.14	4.52	4.08	12,912	12,354

KEY: nec -- Not elsewhere classified.

SOURCE: Standard and Poor's Compustat, Englewood, CO.

Table 3. Comparison between top 500 corporate R&D levels and industry-survey R&D levels: 1997

Page 1 of 2

Standard industrial classification	Major & detailed industrial sector ¹	Corporate R&D 1997 (top 500) (In millions of dollars)	Industry survey 1997 R&D (In millions of dollars)	Corporate R&D (top 500) as a percent of industry-survey R&D
	Total	111,369	133,611	83.35
372,376	Aircraft, guided missiles, & space vehicles	4,673	5,677	82.31
	Basic industries & materials			
07-12,14-17	Agr. services; forestry; fishing; mining; construction.....	203	1,541	13.19
13,29	Oil & gas extraction; petroleum refining & related ind.....	2,474	1,612	153.48
20,21	Food & kindred products; tobacco products.....	1,188	1,787	66.47
22,23	Textile & apparel products.....	77	476	16.20
24,25	Lumber, wood products, & furniture.....	543	348	156.06
26	Paper & allied products.....	1,516	1,456	104.12
27	Printing, publishing, & allied industries.....	159		
31,39	Misc products (leather, toys, jewelry, musicl inst..).....	372	2,642	20.13
30	Rubber & misc. plastic prod. (tires, plastic footwear...).....	555	1,372	40.43
32	Stone, clay, glass, & concrete products.....	412	606	68.03
33-332,3398-99	Ferrous metal products.....	60	414	14.57
333-336	Nonferrous metal products.....	287	353	81.21
34	Fabricated metal products, except machinery & transp. equip.....	508	1,669	30.44
	Chemicals	6,822	7,042	96.87
2800,281-82,286	Industrial chemicals; plastic & other synthetic materials.....	4,295	4,970	86.43
284-85,287-89	Other chem. (soaps, ink, paints, fertilizers, explosives...).....	2,526	2,072	121.92
873	Engineering, accounting, & research/testing services	138	5,909	2.34
60-65,67	Finance, insurance, real estate	81	1,500	5.40
	General services	208	10,256	2.03
40-42,44-47	Transportation; freight & warehousing; & pipeline services.....	68	670	10.15
49	Electric, gas, sanitary services.....	0	258	0.00
50-59	Wholesale & retail trade.....	87	7,961	1.09
731-736,738	Other (noncomputer) bus. serv (advertising, equip. rental...).....	53	242	21.73
701,72,75-79,81,	Lodging, repair, legal, social, consultg, & oth serv; movie prod...	0	446	0.00
83-84,89				
801-809	Hospitals & health care-related laboratories & services.....	0	679	0.00
	Information & electronics	45,824	50,981	89.88
3571,3575	Electronic computers & computer terminals.....	11,094		
3572	Computer storage devices.....	2,607		
3576 (Compustat code)	Computer networking communications equip.....	2,621	12,787	131.84
3577	Computer peripheral equip. (printers, scanners...).....	325		
3578-79	Calculating/accounting mach. & office machines, nec.....	210		
365	Household audio & video equipment, & audio recordings.....	230	152	151.15
3661	Modems & other wired telephone equip.....	4,011		
3663,3669	Radio, TV, cell phone, & satellite comm. equip.....	3,625	7,377	103.52
367	Electronic components (semiconductors, coils...).....	6,648	10,786	61.64

See explanatory information and SOURCE at end of table

Table 3. Comparison between top 500 corporate R&D levels and industry-survey R&D levels: 1997

Page 2 of 2

Standard industrial classification	Major & detailed industrial sector	Corporate R&D 1997 (top 500) (In millions of dollars)	Industry survey 1997 R&D (In millions of dollars)	Corporate R&D (top 500) as a percent of industry- survey R&D
	Information & electronics—continued			
381	Search & navigation equip.....	768		
382	Lab. controlling & measuring instru.	2,423	3,719	85.80
386–387	Optthalmic goods, photograph. equip. & clocks ¹	2,616	2,958	88.44
481–484,489	Communications services (telephone, satellite tracking, radio/TV, cable...).....	1,054	1,884	55.93
7370,7371,7374–5	Multiple & miscel. computer & data processing services.....	540		
7372	Prepackaged software.....	6,619	11,318	67.07
7373	Computer integrated systems design.....	431		
	Machinery & electrical equipment.....	7,039	10,038	70.12
351–56,358–59	Machinery (industl, farm, service ind., mining & constructn).....	3,968	5,606	70.78
361–64,369	Electrical equipment (industrial & household).....	3,071	4,432	69.28
	Medical substances & devices.....	19,849	13,868	143.13
2833	Drugs: medicinal chemicals, botanical products.....	0		
2834	Drugs: pharmaceutical preparations.....	15,733		
2835	Drugs: in vitro, in vivo diagnostic substances.....	593	11,586	153.90
2836	Drugs: biological products, except diagnostic substances.....	1,505		
3841–5	Medical instruments ¹	2,018	2,282	88.44
	Motor vehicles & other surface transportation equipment.....	18,380	14,065	130.68
371	Motor vehicles & motor vehicle equipment.....	18,093	13,758	131.51
373–75,379	Ships, trains, motorcyc, bicycles, campers, military tanks.....	287	307	93.42
	{Classified Differently by Industry Survey}			
384–87	Optthalmic goods, photograph. equip. & clocks ²	N/A	5,240	N/A
	Medical instruments ²			

¹ In the industry survey, some of these detailed sectors are consolidated into a single data item, as indicated by the horizontal lines in the table, displaying a single entry for more than one group of detailed sectors.

² Amounts for industry survey are prorated estimates based on the Corporate R&D data, which were done in order to estimate major sector totals.

KEY: N/A -- Not applicable.
nec -- Not elsewhere classified.

SOURCE: Standard and Poor's Compustat, Englewood, CO; and National Science Foundation/Division of Science Resources Studies, *Research and Development in Industry 1997*, Detailed Statistical Tables, by Raymond M. Wolfe (Arlington, VA, forthcoming).



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